July 3, 2019

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PUBLIC UTILITIES COMMISSION

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UDP

The Honorable Chair and Members of the
Hawai'i Public Utilities Commission
Kekuanaoa Building
465 South King Street, First Floor
Honolulu, Hawai'i 96813

Dear Commissioners:

Subject: Hawaiian Electric Companies Annual Service Reliability Reports for 2018

Hawaiian Electric Company, Inc., Hawai'i Electric Light Company, Inc., and Maui Electric Company, Limited respectfully submit a copy of its Annual Service Reliability Report for the year 2018. (See Attachments 1, 2, and 3, respectively.)

Sincerely,

Kevin M. Katsura
Director
Regulatory Non-Rate Proceedings

Attachments

c: Division of Consumer Advocacy (with Attachments)

HAWAIIAN ELECTRIC COMPANY, INC.

ANNUAL SERVICE RELIABILITY REPORT

2018

Prepared by

Asset Management Division

June 3, 2019

INTRODUCTION

This is Hawaiian Electric Company's 2018 annual service reliability report. The average number of electric customers increased from 304,359 in 2017 to 304,965 in 2018 (a 0.20% increase). The 2018 gross peak demand for the system was 1,225 MW on the evening of September 25, 2018, 12 MW higher than the gross system peak demand of 1,213 MW in 2017; the highest gross system peak demand remains at 1,327 MW set on the evening of October 12, 2004.

The service reliability indices provided in this report are commonly used in the electric power utility industry as a method of measuring system reliability performance. These include overall availability of electrical service (Average Service Availability Index or ASAI), the average frequency or number of times customers experience an interruption of service during the year (System Average Interruption Frequency Index or SAIFI), the average length of time an interrupted customer is out of power (Customer Average Interruption Duration Index or CAIDI), and the average length of time customers are out of power during the year (System Average Interruption Duration Index or SAIDI). SAIDI is an indication of overall system reliability because it incorporates the impact of frequency and duration of outages on the company's total customer base (304,965 customers). The Appendix contains definitions, explanations, and equations for the reliability indices included in this report.

ANALYSIS

The reliability indices provided in this report are calculated using the IEEE Standard 1366-2012 methodology. Indices reported on a normalized basis exclude Major Event Days (MEDs). MEDs are defined as days in which the daily system SAIDI exceeds the MED threshold value (T_{MED}). Statistically, days having a daily system SAIDI greater than T_{MED} indicate days on which the energy delivery system experienced stresses beyond that normally expected (such as during severe weather).[1] In calculating daily system SAIDI, any interruption that spans multiple calendar days is accrued to the day on which the interruption began.

[1] IEEE Std 1366™-2012: IEEE Guide for Electric Power Distribution Reliability Indices.

2018
RESULTS

Annual Service Reliability Indices

The following tables provide reliability index results on a unnormalized and normalized basis for the entire system and separately for 1) transmission and distribution outages, 2) utility generation outages, and 3) non-utility generation outages.

There were two Major Event Days in 2018 that were excluded from the calculation of normalized indices: 8/24/18 due to effects of Hurricane Lane and 9/12/18 due to effects of Tropical Storm Olivia and equipment deterioration.

Table 1: Generation, Transmission, and Distribution Outages – Unnormalized

	2013	2014	2015	2016	2017	2018
Number of Customers	298,920	300,722	302,499	303,732	304,359	304,965
Customer Interruptions	378,953	384,937	578,092	394,758	426,050	404,503
Customer-Hours Interrupted	604,225	537,802	766,068	553,427	703,324	627,251
SAIDI (Minutes)	121.28	107.30	151.95	109.33	138.65	123.41
CAIDI (Minutes)	95.67	83.83	79.51	84.12	99.05	93.04
SAIFI (Occurrences)	1.268	1.280	1.911	1.300	1.400	1.326
ASAI (Percentage)	99.977%	99.980%	99.971%	99.979%	99.974%	99.977%

Table 2: Generation, Transmission, and Distribution Outages – Normalized [2]

	2013	2014	2015	2016	2017	2018
Number of Customers	298,920	300,722	302,499	303,732	304,359	304,965
Customer Interruptions	363,616	384,937	439,687	304,466	350,078	382,106
Customer-Hours Interrupted	539,270	537,802	500,853	421,384	489,908	568,968
SAIDI (Minutes)	108.24	107.30	99.34	83.24	96.58	111.94
CAIDI (Minutes)	88.98	83.83	68.35	83.04	83.97	89.34
SAIFI (Occurrences)	1.216	1.280	1.454	1.002	1.150	1.253
ASAI (Percentage)	99.979%	99.980%	99.981%	99.984%	99.982%	99.979%

[2] Exclusions include:

2/17/13 due to equipment deterioration along Kamehame Ridge
1/2/15 due to high winds and vegetation
2/14/15 due to high winds
2/19/15 due to high winds
7/24/16 due to flooding at Iwilei Substation and surrounding area
1/21/17 due to trees/branches and high winds
1/22/17 due to high winds
2/5/17 due to high winds and vegetation
8/24/18 due to effects of Hurricane Lane
9/12/18 due to effects of Tropical Storm Olivia and equipment deterioration

Table 3: Transmission and Distribution Outages – Unnormalized

	2013	2014	2015	2016	2017	2018
Number of Customers	298,920	300,722	302,499	303,732	304,359	304,965
Customer Interruptions	323,957	352,633	437,534	328,474	397,604	404,502
Customer-Hours Interrupted	575,364	522,491	721,807	506,993	699,880	627,238
SAIDI (Minutes)	115.49	104.25	143.17	100.15	137.97	123.41
CAIDI (Minutes)	106.56	88.90	98.98	92.61	105.61	93.04
SAIFI (Occurrences)	1.084	1.173	1.446	1.081	1.306	1.326
ASAI (Percentage)	99.978%	99.980%	99.973%	99.981%	99.974%	99.977%

Table 4: Utility Generation Outages – Unnormalized

	2013	2014	2015	2016	2017	2018
Number of Customers	298,920	300,722	302,499	303,732	304,359	304,965
Customer Interruptions	0	0	26,914	66,284	17,341	0
Customer-Hours Interrupted	0	0	18,772	46,434	1,776	0
SAIDI (Minutes)	0.00	0.00	3.72	9.17	0.35	0.00
CAIDI (Minutes)	0.00	0.00	41.85	42.03	6.14	0.00
SAIFI (Occurrences)	0.000	0.000	0.089	0.218	0.057	0.000
ASAI (Percentage)	100.000%	100.000%	99.999%	99.998%	100.000%	100.000%

Table 5: Non-Utility Generation Outages – Unnormalized

	2013	2014	2015	2016	2017	2018
Number of Customers	298,920	300,722	302,499	303,732	304,359	304,965
Customer Interruptions	54,996	32,304	113,644	0	11,105	1
Customer-Hours Interrupted	28,861	15,311	25,489	0	1,668	13
SAIDI (Minutes)	5.79	3.05	5.06	0.00	0.33	0.00
CAIDI (Minutes)	31.49	28.44	13.46	0.00	9.01	753.00
SAIFI (Occurrences)	0.184	0.107	0.376	0.000	0.036	0.000
ASAI (Percentage)	99.999%	99.999%	99.999%	100.000%	100.000%	100.000%

Table 6: Transmission and Distribution Outages – Normalized[2]

	2013	2014	2015	2016	2017	2018
Number of Customers	298,920	300,722	302,499	303,732	304,359	304,965
Customer Interruptions	308,620	352,633	321,880	304,466	321,632	382,105
Customer-Hours Interrupted	510,409	522,491	460,172	421,384	486,464	568,955
SAIDI (Minutes)	102.45	104.25	91.27	83.24	95.90	111.94
CAIDI (Minutes)	99.23	88.90	85.78	83.04	90.75	89.34
SAIFI (Occurrences)	1.032	1.173	1.064	1.002	1.057	1.253
ASAI (Percentage)	99.980%	99.980%	99.983%	99.984%	99.982%	99.979%

Table 7: Utility Generation Outages – Normalized[2]

	2013	2014	2015	2016	2017	2018
Number of Customers	298,920	300,722	302,499	303,732	304,359	304,965
Customer Interruptions	0	0	26,914	0	17,341	0
Customer-Hours Interrupted	0	0	18,772	0	1,776	0
SAIDI (Minutes)	0.00	0.00	3.72	0.00	0.35	0.00
CAIDI (Minutes)	0.00	0.00	41.85	0.00	6.14	0.00
SAIFI (Occurrences)	0.000	0.000	0.089	0.000	0.057	0.000
ASAI (Percentage)	100.000%	100.000%	99.999%	100.000%	100.000%	100.000%

Table 8: Non-Utility Generation Outages – Normalized[2]

	2013	2014	2015	2016	2017	2018
Number of Customers	298,920	300,722	302,499	303,732	304,359	304,965
Customer Interruptions	54,996	32,304	90,893	0	11,105	1
Customer-Hours Interrupted	28,861	15,311	21,909	0	1,668	13
SAIDI (Minutes)	5.79	3.05	4.35	0.00	0.33	0.00
CAIDI (Minutes)	31.49	28.44	14.46	0.00	9.01	753.00
SAIFI (Occurrences)	0.184	0.107	0.300	0.000	0.036	0.000
ASAI (Percentage)	99.999%	99.999%	99.999%	100.000%	100.000%	100.000%

The following charts and discussion are based on the reliability index results for generation, transmission, and distribution outages on a normalized basis (data from Table 2 above).

Figure 1: System Average Interruption Duration Index (SAIDI)

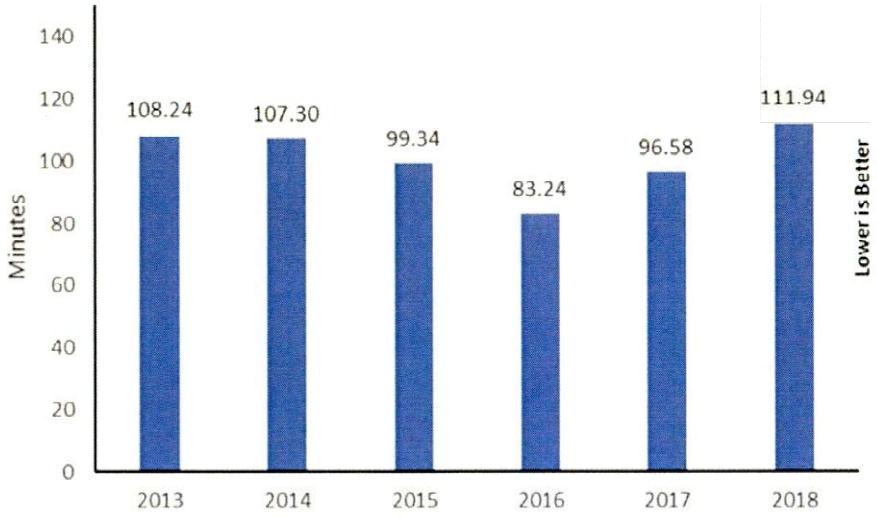


Figure 1 shows the SAIDI values for 2013-2018.

The 2018 SAIDI of 111.94 minutes is a 16% increase compared to the 2017 SAIDI of 96.58 minutes. The customer hours interrupted was 568,968 hours in 2018 compared to 489,908 hours in 2017.

The following events significantly impacted the 2018 SAIDI results:

1. September 4, 2018 (Tuesday) – A switch failed at Aikahi Substation. This affected 13,969 customers from a momentary interruption up to 4 hours and 23 minutes. This event contributed 2.56 minutes to SAIDI.
2. November 10, 2018 (Saturday) – A conductor shorted out due to a motor vehicle accident. This affected 3,814 customers from a momentary interruption up to 3 hours and 11 minutes. This event contributed 2.26 minutes to SAIDI.
3. June 20, 2018 (Wednesday) – Scheduled maintenance to replace a pole in Pacific Palisades affected 2,052 customers for 4 hours and 55 minutes. This event contributed 1.98 minutes to SAIDI.

Figure 2: System Average Interruption Frequency Index (SAIFI)

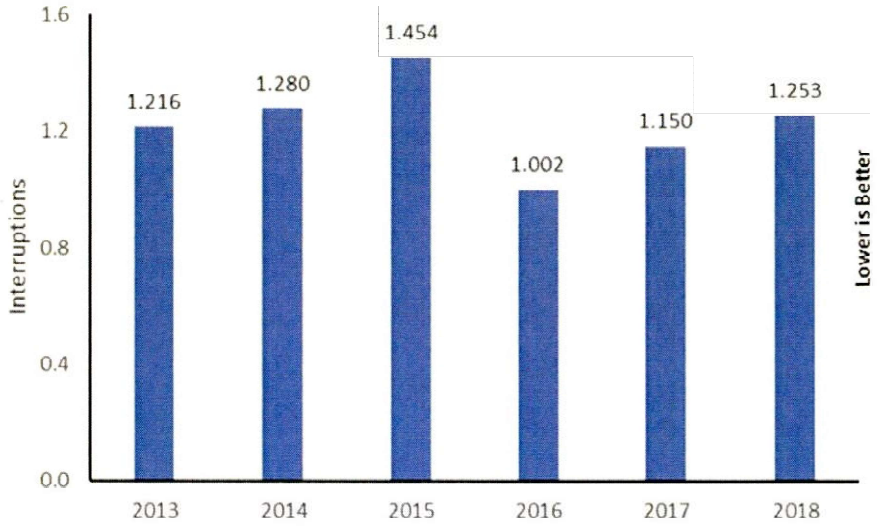


Figure 2 shows the SAIFI values for 2013-2018.

The 2018 SAIFI of 1.253 is a 9% increase from the 2017 SAIFI of 1.150. The number of customer interruptions in 2018 was 382,106 compared to 350,078 customer interruptions in 2017.

The following events significantly impacted the 2018 SAIFI results:

1. April 2, 2018 (Monday) – An air-switch failure at AES Substation resulted in an under-frequency load shed (UFLS) event. This affected 28,853 customers from a momentary interruption up to 19 hours and 40 minutes. This event contributed 0.080 to SAIFI.
2. December 30, 2018 (Sunday) – A downed tree caused downed conductors and broken cross-arms. Two 46 kV sub-transmission circuits were tied together during this event. This affected 15,481 customers from a momentary interruption up to 12 hours and 24 minutes. This event contributed 0.050 to SAIFI.

Figure 3: Customer Average Interruption Duration Index (CAIDI)

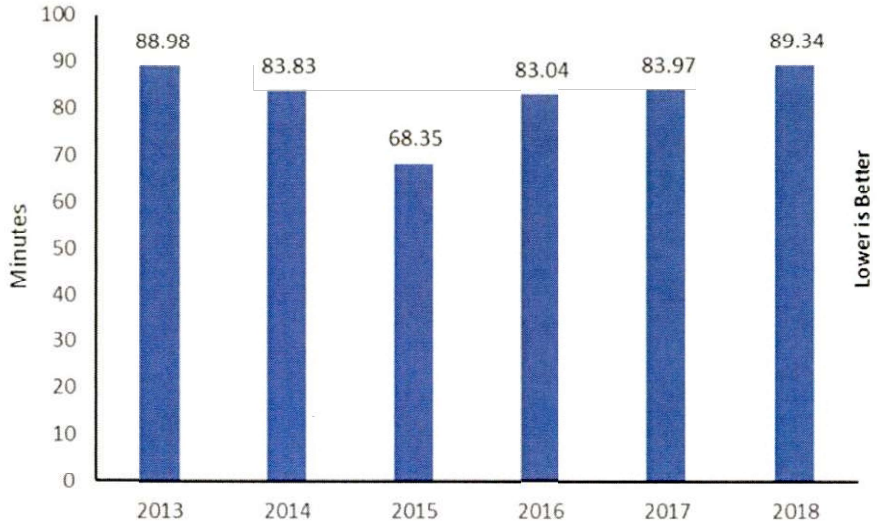


Figure 3 shows the CAIDI values for 2013-2018.

The 2018 CAIDI of 89.34 minutes is a 6.4% increase compared to the 2017 CAIDI of 83.97 minutes. This is the highest annual CAIDI result in the last six years.

The following events significantly affected the 2018 CAIDI results:

1. June 20, 2018 (Wednesday) – Scheduled maintenance to replace a pole in Pacific Palisades affected 2,052 customers for 4 hours and 55 minutes. This event contributed 1.11 minutes to CAIDI.
2. November 10, 2018 (Saturday) – A conductor shorted out due to a motor vehicle accident. This affected 3,814 customers from a momentary interruption up to 3 hours and 11 minutes. This event contributed 0.97 minutes to CAIDI.
3. December 8, 2018 (Saturday) – An outage due to equipment deterioration in a switch vault affected 2,485 customers from a momentary interruption up to 3 hours and 54 minutes. This event contributed 0.70 minutes to CAIDI.

Figure 4: Average System Availability Index (ASAI)

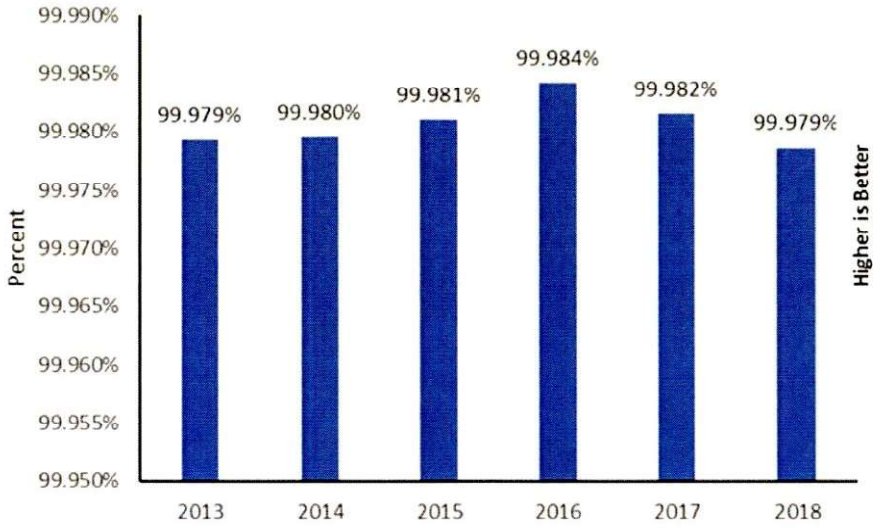
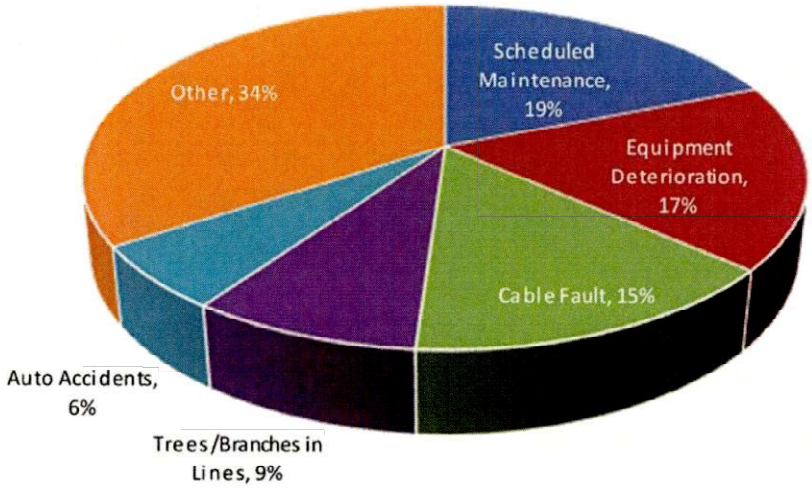


Figure 4 shows the ASAI values for 2013-2018.

The 2018 ASAI of 99.979% is a 0.003% decrease from the 2017 ASAI of 99.982%. The customer hours interrupted was 568,968 hours in 2018 compared to 489,908 hours in 2017.

Figure 5: Outage Causes for 2018



The top five outage causes by customer hours interrupted, as illustrated in Figure 5, accounted for about 66% of the total customer hours interrupted in 2018. These include:

	Top Outage Cause	Description
1.	Scheduled Maintenance	Planned outage to replace/repair equipment
2.	Equipment Deterioration	Failed, broken, or corroded equipment
3.	Cable Fault	Underground cable or cable component failure
4.	Trees/Branches in Lines	Vegetation contacting or falling onto overhead conductors
5.	Automobile Accidents	Motor vehicle collision with company equipment

From 2017 to 2018, Equipment Deterioration remained the 2nd top outage cause, Automobile Accidents went from 3rd to 5th, Scheduled Maintenance went from 4th to 1st, and High Winds was replaced in the top five by Trees/Branches in Line.

Hawaiian Electric Company
Normalized Sustained Interruption Summary

From: January 1, 2018 **To:** December 31, 2018

Outage Cause	Customer Hours	Customer Interruptions	SAIFI	SAIDI	CAIDI
SCHEDULED MAINTENANCE	107,307.83	23,148	0.076	21.11	278.14
EQUIP DETERIORATION	98,013.45	79,824	0.262	19.28	73.67
CABLE FAULT	83,078.23	58,921	0.193	16.35	84.60
TREES/BRANCHES IN LINES	48,956.97	32,200	0.106	9.63	91.22
AUTO ACCIDENT	33,641.40	16,060	0.053	6.62	125.68
UNKNOWN	29,485.05	21,516	0.071	5.80	82.22
SYSTEM LOAD MAINTENANCE	25,170.60	33,656	0.110	4.95	44.87
LIGHTNING	21,883.40	12,794	0.042	4.31	102.63
FORCED MAINTENANCE	17,655.32	14,133	0.046	3.47	74.95
TRANSFORMER FAILURE	13,128.17	9,946	0.033	2.58	79.20
OVERGROWN VEGETATION	12,783.02	7,787	0.026	2.51	98.50
HIGH WINDS	12,455.78	9,193	0.030	2.45	81.30
FAULTY EQUIP OPERATION	9,421.25	6,559	0.022	1.85	86.18
FIRE	9,116.53	4,522	0.015	1.79	120.96
FLASHOVER	7,109.92	5,906	0.019	1.40	72.23
FOREIGN OBJECT IN LINES	7,084.42	5,872	0.019	1.39	72.39
COMPANY PERSONNEL ERROR	6,226.32	11,676	0.038	1.22	32.00
CONSTRUCTION ACCIDENT	5,223.78	4,564	0.015	1.03	68.67
ANIMAL IN LINES	5,067.55	5,302	0.017	1.00	57.35
MYLAR BALLOON	4,583.00	5,649	0.019	0.90	48.68
COMPANY SWITCHING ERROR	3,361.60	6,497	0.021	0.66	31.04
VANDALISM	3,133.82	1,573	0.005	0.62	119.54
CUSTOMER EQUIP	2,055.30	1,700	0.006	0.40	72.54
OTHER	1,575.03	1,680	0.006	0.31	56.25
CONTAMINATION FLASHOVER	1,359.32	1,342	0.004	0.27	60.77
TRANSFORM OVERLOAD	85.12	82	0.000	0.02	62.28
EQUIP OVERLOAD	5.50	4	0.000	0.00	82.50
CUSTOMER MAINTENANCE	0.00	0	0.000	0.00	0.00
AUTO UF LOADSHED	0.00	0	0.000	0.00	0.00
EQUIP ROT OR TERMITES	0.00	0	0.000	0.00	0.00
IPP EQUIP FAILURE	0.00	0	0.000	0.00	0.00
LANDSLIDE/FLOODING	0.00	0	0.000	0.00	0.00
MAN IN LINES	0.00	0	0.000	0.00	0.00
MANUAL UF LOADSHED	0.00	0	0.000	0.00	0.00
MANUFACTURER EQUIP DEFECT	0.00	0	0.000	0.00	0.00
MOVING EQUIP ACCIDENT	0.00	0	0.000	0.00	0.00
NATURAL DISASTER	0.00	0	0.000	0.00	0.00
OTHER-GENERATION	0.00	0	0.000	0.00	0.00
SWITCH LOAD MAINTENANCE	0.00	0	0.000	0.00	0.00
TRANSFER LOAD MAINTENANCE	0.00	0	0.000	0.00	0.00
Total	**568,967.67**	**382,106**	**1.253**	**111.94**	**89.34**

AVERAGE SYSTEM AVAILABILITY =	99.979%
NUMBER OF CUSTOMERS FOR THE PERIOD =	304,965
24 MONTH ANNUALIZED SAIDI AVERAGE FOR THE PERIOD 1/1/2017 - 12/31/2018 =	104.27
24 MONTH AVAERAGE NUMBER OF CUSTOMERS FOR THE PERIOD 1/1/2017 - 12/31/2018 =	304,662

NOTES: OUTAGE CAUSES ARE LISTED IN ORDER OF SAIDI.
OUTAGES WITH ZERO CUSTOMER HOURS OR DUE TO CUSTOMER MAINTENANCE ARE NOT INCLUDED IN THE REPORT.

Hawaiian Electric Company
Normalized Sustained Interruption Summary

From: January 1, 2018 **To:** December 31, 2018

	Interruption Count	% of Total	Customer Hours	% of Total
EQUIPMENT	**866**	**32.65%**	**212,200.95**	**37.30%**
EQUIP DETERIORATION	234	8.82%	98,013.45	17.23%
CABLE FAULT	534	20.14%	83,078.23	14.60%
TRANSFORMER FAILURE	62	2.34%	13,128.17	2.31%
FAULTY EQUIP OPERATION	15	0.57%	9,421.25	1.66%
FLASHOVER	10	0.38%	7,109.92	1.25%
CONTAMINATION FLASHOVER	2	0.08%	1,359.32	0.24%
TRANSFORM OVERLOAD	7	0.26%	85.12	0.01%
EQUIP OVERLOAD	2	0.08%	5.50	0.00%
MANUFACTURER EQUIP DEFECT	0	0.00%	0.00	0.00%
EQUIP ROT OR TERMITES	0	0.00%	0.00	0.00%
ERROR	**40**	**1.51%**	**9,587.92**	**1.69%**
COMPANY PERSONNEL ERROR	29	1.09%	6,226.32	1.09%
COMPANY SWITCHING ERROR	11	0.41%	3,361.60	0.59%
GENERATION	**0**	**0.00%**	**0.00**	**0.00%**
AUTO UF LOADSHED	0	0.00%	0.00	0.00%
IPP EQUIP FAILURE	0	0.00%	0.00	0.00%
MANUAL UF LOADSHED	0	0.00%	0.00	0.00%
OTHER-GENERATION	0	0.00%	0.00	0.00%
MAINTENANCE	**1,236**	**46.61%**	**150,133.75**	**26.39%**
SCHEDULED MAINTENANCE	1,040	39.22%	107,307.83	18.86%
SYSTEM LOAD MAINTENANCE	43	1.62%	25,170.60	4.42%
FORCED MAINTENANCE	153	5.77%	17,655.32	3.10%
SWITCH LOAD MAINTENANCE	0	0.00%	0.00	0.00%
TRANSFER LOAD MAINTENANCE	0	0.00%	0.00	0.00%
UNKNOWN	**186**	**7.01%**	**29,485.05**	**5.18%**
UNKNOWN	186	7.01%	29,485.05	5.18%
OTHER	**12**	**0.45%**	**1,575.03**	**0.28%**
OTHER	12	0.45%	1,575.03	0.28%
VEGETATION	**126**	**4.75%**	**61,739.98**	**10.85%**
TREES/BRANCHES IN LINES	99	3.73%	48,956.97	8.60%
OVERGROWN VEGETATION	27	1.02%	12,783.02	2.25%
WEATHER	**72**	**2.71%**	**34,339.18**	**6.04%**
LIGHTNING	50	1.89%	21,883.40	3.85%
HIGH WINDS	22	0.83%	12,455.78	2.19%
LANDSLIDE/FLOODING	0	0.00%	0.00	0.00%
NATURAL DISASTER	0	0.00%	0.00	0.00%
PUBLIC (NON-UTILITY)	**114**	**4.30%**	**69,905.80**	**12.29%**
AUTO ACCIDENT	26	0.98%	33,641.40	5.91%
FIRE	5	0.19%	9,116.53	1.60%
FOREIGN OBJECT IN LINES	7	0.26%	7,084.42	1.25%
CONSTRUCTION ACCIDENT	15	0.57%	5,223.78	0.92%
ANIMAL IN LINES	24	0.90%	5,067.55	0.89%
MYLAR BALLOON	10	0.38%	4,583.00	0.81%
VANDALISM	1	0.04%	3,133.82	0.55%
CUSTOMER EQUIP	26	0.98%	2,055.30	0.36%
CUSTOMER MAINTENANCE	0	0.00%	0.00	0.00%
MOVING EQUIP ACCIDENT	0	0.00%	0.00	0.00%
MAN IN LINES	0	0.00%	0.00	0.00%
Total:	**2,652**		**568,967.67**	

NOTES: OUTAGES WITH ZERO CUSTOMER HOURS OR DUE TO CUSTOMER MAINTENANCE ARE NOT INCLUDED IN THE REPORT.

DEFINITION OF TERMS

OUTAGE

The state of a component when it is not available to perform its intended function due to some event directly associated with that component. An outage may or may not cause an interruption of service to consumers depending on the system configuration.

INTERRUPTION

The loss of service to one or more consumers and is a result of one or more component outages.

INTERRUPTION DURATION

The period from the initiation of an interruption to a consumer until service has been restored to that consumer.

MOMENTARY INTERRUPTION

An interruption that has a duration limited to the period required to restore service by automatic or supervisory-controlled switching operations or by manual switching at locations where an operator is immediately available. Such switching operations must be completed in a specific time not to exceed five minutes. Previous issues of this report indicated that a momentary interruption has duration not to exceed one minute. IEEE Std 1366™-2012: IEEE Guide for Electric Power Distribution Reliability Indices indicated that momentary interruptions will have duration of five minutes or less.

SUSTAINED INTERRUPTION

Any interruption not classified as a momentary interruption. Only this type of interruption is included in the reliability indices within this report. In conformance with the guidelines established in the IEEE Std 1366™-2012: IEEE Guide for Electric Power Distribution Reliability Indices, a sustained interruption has duration of over five minutes.

CUSTOMER INTERRUPTION

One interruption of one customer.

NOTE: Interruptions to customers at their request (e.g., customer maintenance) are not considered.

RELIABILITY INDICES

Reliability indices used in this report conform to standards proposed by both the Edison Electric Institute (EEI) and the Institute of Electrical and Electronics Engineers (IEEE) unless otherwise indicated in the above definitions. Five reliability indices that convey a meaningful representation of the level of reliability were selected and are presented in this report. These reliability indices are as follows:

AVERAGE SERVICE AVAILABILITY INDEX (ASAI)

Total customer hours actually served as a percentage of total customer hours possible during the year. This indicates the extent to which electrical service was available to all customers. This index has been commonly referred to as the "Index of Reliability." A customer-hour is calculated by multiplying the number of customers by the number of hours in the period being analyzed.

$$ASAI = \frac{\sum \text{No. of Customer Hours Actually Served During the year}}{\sum No. of\ Customer\ Hours\ Possible\ During\ the\ year} \times 100\%$$

SYSTEM AVERAGE INTERRUPTION FREQUENCY INDEX (SAIFI)

The number of customer interruptions per customer served during the year. This index indicates the average number of sustained interruptions experienced by all customers serviced on the system.

$$SAIFI = \frac{\sum \text{No. of Customer Interruptions Experienced During the year}}{\text{Average No. of Customers Served During the year}}$$

CUSTOMER AVERAGE INTERRUPTION DURATION INDEX (CAIDI)

The interruption duration per customer interrupted during the year. This index indicates the average duration of an interruption for those customers affected by a sustained interruption.

$$CAIDI = \frac{\sum \text{Duration of Interruptions} \times \text{No. of Customers Affected}}{\sum \text{No. of Customer Interruptions Experienced During the year}}$$

SYSTEM AVERAGE INTERRUPTION DURATION INDEX (SAIDI)

The interruption duration per customer served during the year. This index indicates the average interruption time experienced by all customers serviced on the system.

$$SAIDI = \frac{\sum \text{Duration of Interruptions} \times \text{No. of Customers Affected}}{\text{Average No. of Customers Served During the year}}$$

HAWAI'I ELECTRIC LIGHT COMPANY, INC.

ANNUAL SERVICE RELIABILITY REPORT

2018

Prepared by

Asset Management Division

June 3, 2019

INTRODUCTION

This is Hawaii Electric Light Company's 2018 annual service reliability report. The average number of electric customers increased from 85,041 in 2017 to 85,408 in 2018 (0.43% increase). The 2018 net peak demand for the system was 190.8MW on the evening of December 27, 2018, 0.3 MW higher than the net peak demand of 190.5 MW in 2017.

The service reliability indices provided in this report are commonly used in the electric power utility industry as a method of measuring system reliability performance. These include overall availability of electrical service (Average Service Availability Index or ASAI), the average frequency or number of times customers experience an interruption of service during the year (System Average Interruption Frequency Index or SAIFI), the average length of time an interrupted customer is out of power (Customer Average Interruption Duration Index or CAIDI), and the average length of time customers are out of power during the year (System Average Interruption Duration Index or SAIDI). SAIDI is an indication of overall system reliability because it incorporates the impact of frequency and duration of outages on the company's total customer base (85,408 customers). The Appendix contains definitions, explanations, and equations for the reliability indices included in this report.

ANALYSIS

The reliability indices provided in this report are calculated using the IEEE Standard 1366-2012 methodology. Indices reported on a normalized basis exclude Major Event Days (MEDs). MEDs are defined as days in which the daily system SAIDI exceeds the MED threshold value (T_{MED}). Statistically, days having a daily system SAIDI greater than T_{MED} indicate days on which the energy delivery system experienced stresses beyond that normally expected (such as during severe weather).[1] In calculating daily system SAIDI, any interruption that spans multiple calendar days is accrued to the day on which the interruption began.

[1] IEEE Std 1366™-2012: IEEE Guide for Electric Power Distribution Reliability Indices.

2018 RESULTS

Annual Service Reliability Indices

The following tables provide reliability index results on a unnormalized and normalized basis for the entire system and separately for 1) transmission and distribution outages, 2) utility generation outages, and 3) non-utility generation outages.

There were no Major Event Days in 2018 that were excluded from the calculation of normalized indices.

Table 1: Generation, Transmission, and Distribution Outages – Unnormalized

	2013	2014	2015	2016	2017	2018
Number of Customers	82,068	82,872	83,622	84,367	85,041	85,408
Customer Interruptions	256,351	324,546	345,143	196,249	151,681	216,840
Customer-Hours Interrupted	271,011	1,316,984	661,703	247,641	263,828	328,406
SAIDI (Minutes)	198.14	953.50	474.78	176.12	186.14	230.71
CAIDI (Minutes)	63.43	243.48	115.03	75.71	104.36	90.87
SAIFI (Occurrences)	3.124	3.916	4.127	2.326	1.784	2.539
ASAI (Percentage)	99.962%	99.818%	99.909%	99.966%	99.964%	99.956%

Table 2: Generation, Transmission, and Distribution Outages – Normalized [2]

	2013	2014	2015	2016	2017	2018
Number of Customers	82,068	82,872	83,622	84,367	85,041	85,408
Customer Interruptions	231,786	225,903	192,196	185,013	128,861	216,840
Customer-Hours Interrupted	173,213	238,159	214,740	204,049	191,415	328,406
SAIDI (Minutes)	126.64	172.43	154.08	145.12	135.05	230.71
CAIDI (Minutes)	44.84	63.26	67.04	66.17	89.13	90.87
SAIFI (Occurrences)	2.824	2.726	2.298	2.193	1.515	2.539
ASAI (Percentage)	99.976%	99.967%	99.971%	99.972%	99.974%	99.956%

[2] Exclusions include:
- 6/26/13 due to Waimea Substation upgrade
- 6/27/13 due to Waimea Substation upgrade
- 7/29/13 due to effects of Tropical Storm Flossie
- 8/13/13 due to Waimea Switching Station upgrade
- 8/14/13 due to Waimea Switching Station upgrade
- 1/22/14 due to high winds and vegetation
- 8/7/14 due to effects of Hurricane Iselle
- 8/8/14 due to effects of Hurricane Iselle
- 8/16/14 due to effects of Hurricane Iselle
- 12/24/14 due to underfrequency load shed due to Independent Power Producer equipment trip and motor vehicle accident
- 1/2/15 due to high winds
- 1/3/15 due to high winds
- 2/14/15 due to high winds
- 7/23/16 due to effects of Tropical Storm Darby
- 9/21/17 due to scheduled substation maintenance
- 12/5/17 due to high winds

Table 3: Transmission and Distribution Outages – Unnormalized

	2013	2014	2015	2016	2017	2018
Number of Customers	82,068	82,872	83,622	84,367	85,041	85,408
Customer Interruptions	156,185	206,679	261,025	118,879	120,857	137,897
Customer-Hours Interrupted	255,445	1,294,614	644,887	227,989	259,368	297,702
SAIDI (Minutes)	186.76	937.31	462.72	162.14	182.99	209.14
CAIDI (Minutes)	98.13	375.83	148.24	115.07	128.76	129.53
SAIFI (Occurrences)	1.903	2.494	3.121	1.409	1.421	1.615
ASAI (Percentage)	99.964%	99.821%	99.912%	99.969%	99.965%	99.960%

Table 4: Utility Generation Outages – Unnormalized

	2013	2014	2015	2016	2017	2018
Number of Customers	82,068	82,872	83,622	84,367	85,041	85,408
Customer Interruptions	66,919	80,034	76,909	58,077	22,253	28,948
Customer-Hours Interrupted	11,207	13,347	16,017	16,766	2,728	16,346
SAIDI (Minutes)	8.19	9.66	11.49	11.92	1.92	11.48
CAIDI (Minutes)	10.05	10.01	12.50	17.32	7.36	33.88
SAIFI (Occurrences)	0.815	0.966	0.920	0.688	0.262	0.339
ASAI (Percentage)	99.998%	99.998%	99.998%	99.998%	100.000%	99.998%

Table 5: Non-Utility Generation Outages – Unnormalized

	2013	2014	2015	2016	2017	2018
Number of Customers	82,068	82,872	83,622	84,367	85,041	85,408
Customer Interruptions	33,247	37,833	7,209	19,293	8,571	49,995
Customer-Hours Interrupted	4,359	9,023	799	2,886	1,731	14,357
SAIDI (Minutes)	3.19	6.53	0.57	2.05	1.22	10.09
CAIDI (Minutes)	7.87	14.31	6.65	8.97	12.12	17.23
SAIFI (Occurrences)	0.405	0.457	0.086	0.229	0.101	0.585
ASAI (Percentage)	99.999%	99.999%	100.000%	100.000%	100.000%	99.998%

Table 6: Transmission and Distribution Outages – Normalized[2]

	2013	2014	2015	2016	2017	2018
Number of Customers	82,068	82,872	83,622	84,367	85,041	85,408
Customer Interruptions	131,620	136,032	108,078	107,643	98,037	137,897
Customer-Hours Interrupted	157,647	223,795	197,925	184,397	186,955	297,702
SAIDI (Minutes)	115.26	162.03	142.01	131.14	131.90	209.14
CAIDI (Minutes)	71.86	98.71	109.88	102.78	114.42	129.53
SAIFI (Occurrences)	1.604	1.641	1.292	1.276	1.153	1.615
ASAI (Percentage)	99.978%	99.969%	99.973%	99.975%	99.975%	99.960%

Table 7: Utility Generation Outages – Normalized[2]

	2013	2014	2015	2016	2017	2018
Number of Customers	82,068	82,872	83,622	84,367	85,041	85,408
Customer Interruptions	66,919	80,034	76,909	58,077	22,253	28,948
Customer-Hours Interrupted	11,207	13,347	16,017	16,766	2,728	16,346
SAIDI (Minutes)	8.19	9.66	11.49	11.92	1.92	11.48
CAIDI (Minutes)	10.05	10.01	12.50	17.32	7.36	33.88
SAIFI (Occurrences)	0.815	0.966	0.920	0.688	0.262	0.339
ASAI (Percentage)	99.998%	99.998%	99.998%	99.998%	100.000%	99.998%

Table 8: Non-Utility Generation Outages – Normalized[2]

	2013	2014	2015	2016	2017	2018
Number of Customers	82,068	82,872	83,622	84,367	85,041	85,408
Customer Interruptions	33,247	9,837	7,209	19,293	8,571	49,995
Customer-Hours Interrupted	4,359	1,017	799	2,886	1,731	14,357
SAIDI (Minutes)	3.19	0.74	0.57	2.05	1.22	10.09
CAIDI (Minutes)	7.87	6.20	6.65	8.97	12.12	17.23
SAIFI (Occurrences)	0.405	0.119	0.086	0.229	0.101	0.585
ASAI (Percentage)	99.999%	100.000%	100.000%	100.000%	100.000%	99.998%

The following charts and discussion are based on the reliability index results for generation, transmission, and distribution outages on a normalized basis (data from Table 2 above).

Figure 1: System Average Interruption Duration Index (SAIDI)

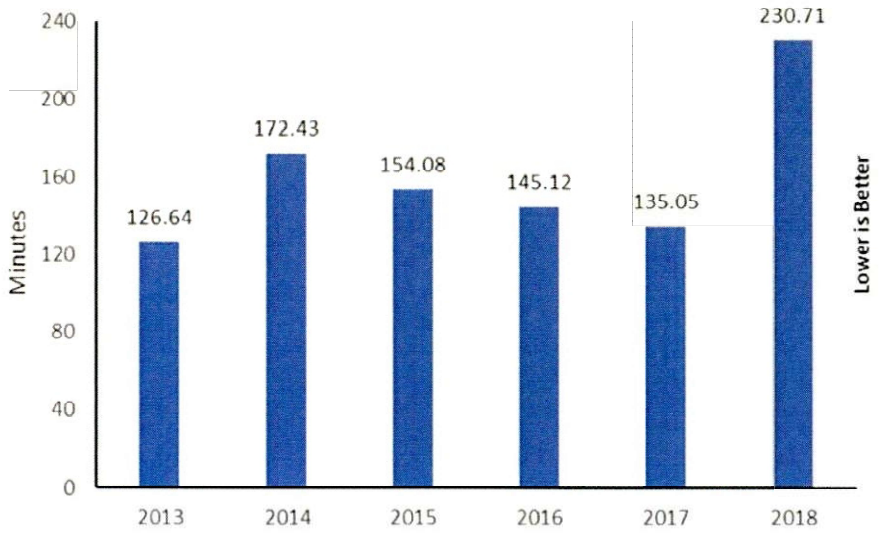


Figure 1 shows the SAIDI values for 2013-2018.

The 2018 SAIDI of 230.71 minutes is a 71% increase compared to the 2017 SAIDI of 135.05 minutes. The customer hours interrupted was 328,406 in 2018 compared to 191,415 in 2017. In the last six years, 2018 had the highest SAIDI of 230.71 minutes.

The following events significantly impacted the 2018 SAIDI results:

1. August 23 to August 27, 2018 (Thursday to Monday) – The effects of Hurricane Lane affected 28,358 customers from a momentary interruption up to 28 hours and 50 minutes. This event contributed 21.23 minutes to SAIDI.
2. April 14, 2018 (Saturday) – Lightning struck two transmission poles. This affected 2,101 customers from 6 hours and 53 minutes up to 9 hours and 16 minutes. This event contributed 11.62 minutes to SAIDI.
3. December 15, 2018 (Saturday) – A transmission line broke at the insulator due to high winds and resulted in downed conductors. This affected 2,079 customers from 7 hours and 37 minutes up to 7 hours and 40 minutes. This event contributed 11.13 minutes to SAIDI.
4. November 5, 2018 (Monday) – A large tree fell across the street, resulting in downed conductors and broken cross-arms. This affected 5,717 customers from a momentary interruption up to 9 hours and 5 minutes. This event contributed 10.81 minutes to SAIDI.

Figure 2: System Average Interruption Frequency Index (SAIFI)

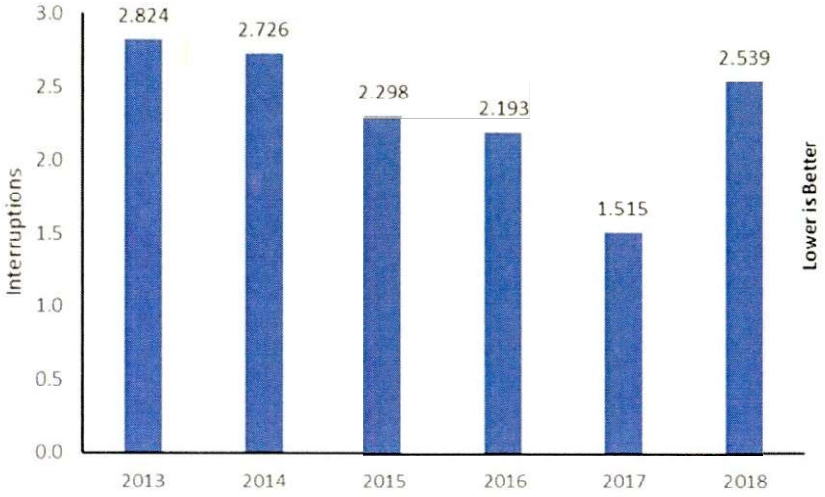


Figure 2 shows the SAIFI values for 2013-2018.

The 2018 SAIFI of 2.539 is a 68% increase from the 2017 SAIFI of 1.515. The number of customer interruptions was 216,840 in 2018 compared to 128,861 interruptions in 2017.

The following events significantly impacted the 2018 SAIFI results:

1. September 2, 2018 (Sunday) – Hamakua Energy tripped offline. This affected 40,834 customers from a momentary interruption up to 1 hour and 2 minutes. This event contributed 0.398 to SAIFI.
2. August 23 to August 27, 2018 (Thursday to Monday) – The effects of Hurricane Lane affected 28,358 customers from a momentary interruption up to 28 hours and 50 minutes. This event contributed 0.144 to SAIFI.
3. September 6, 2018 (Thursday) – A generation issue at Hill 5 and Keahole CT-5 resulted in an under-frequency load shed (UFLS) event. This affected 24,461 customers from 11 minutes up to 40 minutes. This event contributed 0.286 to SAIFI.
4. May 4, 2018 (Friday) – Two earthquakes during the Kilauea Lava eruption affected 15,993 customers from a momentary interruption up to 6 hours and 46 minutes. This event contributed 0.170 to SAIFI.
5. June 21, 2018 (Thursday) – A tree-trimmer dropped a tree on conductors. This affected 12,683 customers from 7 minutes up to 6 hours and 46 minutes. This event contributed 0.148 to SAIFI.
6. July 15, 2018 () – A generation issue at an Independent Power Producer resulted in a UFLS event. This affected 7,466 customers from 8 minutes up to 23 minutes. This event contributed 0.087 to SAIFI.
7. November 20, 2018 (Tuesday) – Faulty equipment operation due to a recently installed substation breaker affected 7,075 customers from 40 minutes up to 2 hours and 16 minutes. This event contributed 0.083 to SAIFI.
8. December 20, 2018 (Thursday) – A generation issue at an Independent Power Producer resulted in a UFLS event. This affected 6,947 customers from a momentary interruption up to 7 minutes. This event contributed 0.067 to SAIFI.
9. November 5, 2018 (Monday) – A large tree fell across the street, resulting in downed conductors and broken cross-arms. This affected 5,717 customers from a momentary interruption up to 9 hours and 5 minutes. This event contributed 0.063 to SAIFI.

Figure 3: Customer Average Interruption Duration Index (CAIDI)

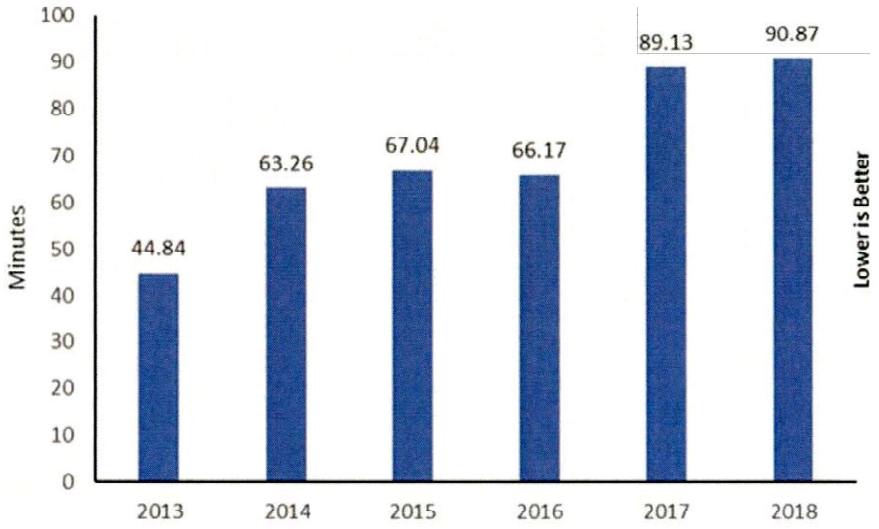


Figure 3 shows the CAIDI values for 2013-2018.

The 2018 CAIDI was 90.87 minutes, an 2% increase compared to the 207 CAIDI result of 89.13 minutes. This is the highest annual CAIDI result in the last six years.

The following events significantly affected the 2018 CAIDI results:

1. April 14, 2018 (Saturday) – Lightning struck two transmission poles. This affected 2,101 customers from 6 hours and 53 minutes up to 9 hours and 16 minutes. This event contributed 3.73 minutes to CAIDI.
2. December 15, 2018 (Saturday) – A transmission line broke at the insulator due to high winds and resulted in downed conductors. This affected 2,079 customers from 7 hours and 37 minutes up to 7 hours and 40 minutes. This event contributed 3.55 minutes to CAIDI.
3. January 15, 2018 (Monday) – A motor vehicle accident affected 3,270 customers from 51 minutes up to 7 hours and 18 minutes. This event contributed 2.44 minutes to CAIDI.
4. November 5, 2018 (Monday) – A large tree fell across the street, resulting in downed conductors and broken crossarms. This affected 5,717 customers from a momentary interruption up to 9 hours and 5 minutes. This event contributed 2.05 minutes to CAIDI.

Figure 4: Average System Availability Index (ASAI)

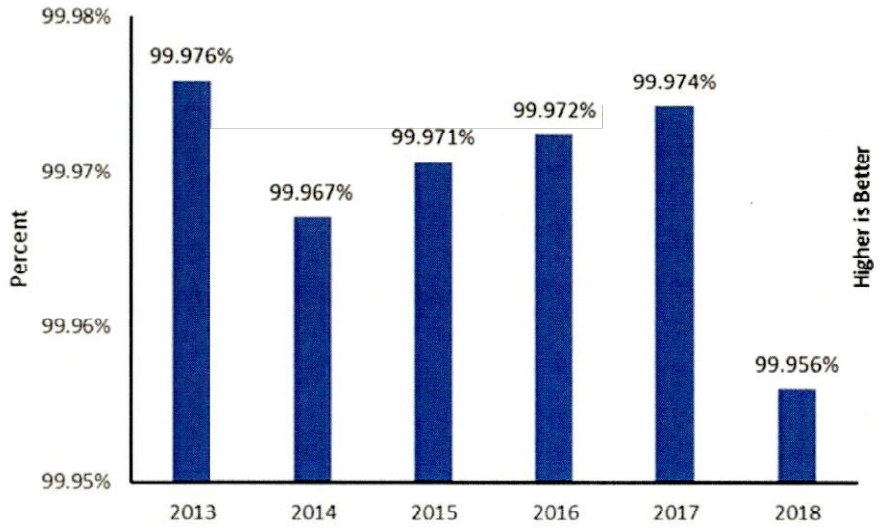
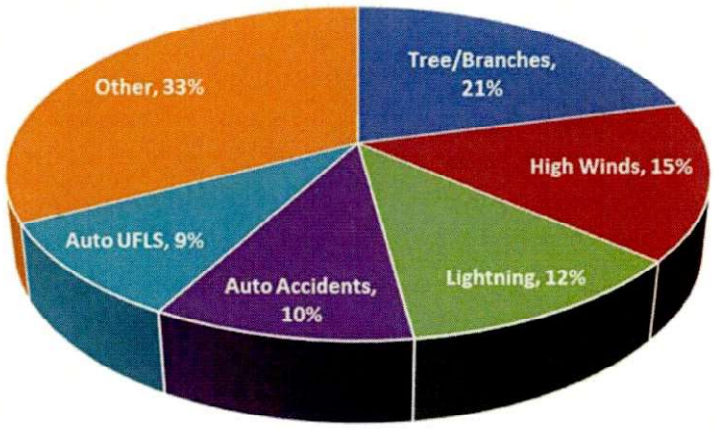


Figure 4 shows the ASAI values for 2013-2018.

The 2018 ASAI of 99.965% was a .018% decrease from the 2017 ASAI of 99.974%. The 2018 ASAI was the lowest ASAI of the last six years. The customer hours interrupted was 328,406 in 2018 compared to 191,415 hours in 2017.

Figure 5: Outage Causes for 2018



The top five outage causes by customer hours interrupted, as illustrated in Figure 5, accounted for about 67% of the total customer hours interrupted in 2018. These include:

	Top Outage Cause	Description
1.	Tree/Branches	Vegetation contacting or falling onto overhead conductors
2.	High Winds	Broken equipment due to high winds
3.	Lightning	Lightning striking company equipment
4.	Auto Accidents	Motor vehicle collision with company equipment
5.	Auto UFLS	Under-frequency load shed (UFLS) due to loss of generation

From 2017 to 2018, Tree/Branches remained the top outage cause and Auto Accidents went from 2nd to 4th. Equipment Deterioration and Overgrown were replaced in the top five by High Winds, Lightning, and Auto UFLS.

Hawai'i Electric Light Company
Normalized Sustained Interruption Summary

From: January 1, 2018 **To:** December 31, 2018

Outage Cause	Customer Hours	Customer Interruptions	SAIFI	SAIDI	CAIDI
Tree/Branches	68,916.65	30,883	0.362	48.41	133.89
High Winds	50,025.18	17,186	0.201	35.14	174.65
Lightning	38,288.10	8,189	0.096	26.90	280.53
Accident - Auto	33,250.09	11,907	0.139	23.36	167.55
Auto UFLS	30,703.45	78,943	0.924	21.57	23.34
Deterioration/Corrosion	27,350.05	13,066	0.153	19.21	125.59
Unknown	14,629.30	5,251	0.061	10.28	167.16
Landslide	12,824.90	16,675	0.195	9.01	46.15
Faulty Operation	12,271.32	7,075	0.083	8.62	104.07
Accident - Construction	12,066.35	12,996	0.152	8.48	55.71
Cable Fault	9,437.77	4,307	0.050	6.63	131.48
Overgrown	7,938.79	3,293	0.039	5.58	144.65
Scheduled	3,368.61	1,090	0.013	2.37	185.43
Other	2,207.63	515	0.006	1.55	257.20
System Change	1,829.98	405	0.005	1.29	271.11
Object in line - Animal	1,310.76	253	0.003	0.92	310.85
Transformer - Failure	1,044.18	210	0.002	0.73	298.34
Other Company Personnel	740.98	3,983	0.047	0.52	11.16
Switching	87.08	519	0.006	0.06	10.07
Forced	44.17	36	0.000	0.03	73.61
Heavy Rain	28.57	2	0.000	0.02	857.00
Object in line - Foreign Object	22.93	43	0.001	0.02	32.00
Transformer - Overload	11.25	8	0.000	0.01	84.38
Customer - Equipment	5.80	1	0.000	0.00	348.00
Fire	1.67	4	0.000	0.00	25.00
Accident - Other	0.00	0	0.000	0.00	0.00
Customer - Requested	0.00	0	0.000	0.00	0.00
Failure/Defect	0.00	0	0.000	0.00	0.00
Flashover	0.00	0	0.000	0.00	0.00
Flooding	0.00	0	0.000	0.00	0.00
Manual load shed	0.00	0	0.000	0.00	0.00
Natural Disaster/Tsunami/Earthquake	0.00	0	0.000	0.00	0.00
Object in line - Balloon	0.00	0	0.000	0.00	0.00
Object in line - Man	0.00	0	0.000	0.00	0.00
Overload	0.00	0	0.000	0.00	0.00
Vandalism	0.00	0	0.000	0.00	0.00
Totals	**328,405.55**	**216,840**	**2.539**	**230.71**	**90.87**

AVERAGE SYSTEM AVAILABILITY =	99.956%
NUMBER OF CUSTOMERS FOR THE PERIOD –	85,408
24 MONTH ANNUALIZED SAIDI AVERAGE FOR THE PERIOD 1/1/2017 - 12/31/2018 =	182.98
24 MONTH AVERAGE NUMBER OF CUSTOMERS FOR THE PERIOD 1/1/2017 - 12/31/2018 =	85,225

NOTES: OUTAGE CAUSES ARE LISTED IN ORDER OF SAIDI.
OUTAGES WITH ZERO CUSTOMER HOURS OR DUE TO CUSTOMER MAINTENANCE ARE NOT INCLUDED IN THE REPORT.

Hawai'i Electric Light Company
Normalized Sustained Interruption Summary

From: January 1, 2018 **To:** December 31, 2018

	Interruption Count	% of Total	Customer Hours	% of Total
EQUIPMENT	**219**	**20.13%**	**50,114.57**	**15.26%**
Deterioration/Corrosion	129	11.86%	27,350.05	8.33%
Faulty Operation	1	0.09%	12,271.32	3.74%
Cable Fault	53	4.87%	9,437.77	2.87%
Transformer - Failure	35	3.22%	1,044.18	0.32%
Transformer - Overload	1	0.09%	11.25	0.00%
Failure/Defect	0	0.00%	0.00	0.00%
Overload	0	0.00%	0.00	0.00%
Flashover	0	0.00%	0.00	0.00%
ERROR	**10**	**0.92%**	**828.05**	**0.25%**
Other Company Personnel	9	0.83%	740.98	0.23%
Switching	1	0.09%	87.08	0.03%
GENERATION	**7**	**0.64%**	**30,703.45**	**9.35%**
Auto UFLS	7	0.64%	30,703.45	9.35%
Manual load shed	0	0.00%	0.00	0.00%
MAINTENANCE	**156**	**14.34%**	**5,242.76**	**1.60%**
Scheduled	111	10.20%	3,368.61	1.03%
System Change	38	3.49%	1,829.98	0.56%
Forced	7	0.64%	44.17	0.01%
UNKNOWN	**60**	**5.51%**	**14,629.30**	**4.45%**
Unknown	60	5.51%	14,629.30	4.45%
OTHER	**1**	**0.09%**	**2,207.63**	**0.67%**
Other	1	0.09%	2,207.63	0.67%
VEGETATION	**316**	**29.04%**	**76,855.43**	**23.40%**
Tree/Branches	237	21.78%	68,916.65	20.99%
Overgrown	79	7.26%	7,938.79	2.42%
WEATHER	**254**	**23.35%**	**101,166.75**	**30.81%**
High Winds	71	6.53%	50,025.18	15.23%
Lightning	171	15.72%	38,288.10	11.66%
Landslide	11	1.01%	12,824.90	3.91%
Heavy Rain	1	0.09%	28.57	0.01%
Natural Disaster/Tsunami/Earthquake	0	0.00%	0.00	0.00%
Flooding	0	0.00%	0.00	0.00%
PUBLIC (NON-UTILITY)	**65**	**5.97%**	**46,657.59**	**14.21%**
Accident - Auto	30	2.76%	33,250.09	10.12%
Accident - Construction	15	1.38%	12,066.35	3.67%
Object in line - Animal	17	1.56%	1,310.76	0.40%
Object in line - Foreign Object	1	0.09%	22.93	0.01%
Customer - Equipment	1	0.09%	5.80	0.00%
Fire	1	0.09%	1.67	0.00%
Accident - Other	0	0.00%	0.00	0.00%
Object in line - Balloon	0	0.00%	0.00	0.00%
Object in line - Man	0	0.00%	0.00	0.00%
Customer - Requested	0	0.00%	0.00	0.00%
Vandalism	0	0.00%	0.00	0.00%
Total	**1,088**		**328,405.55**	

NOTE: OUTAGES WITH ZERO CUSTOMER HOURS OR DUE TO CUSTOMER MAINTENANCE ARE NOT INCLUDED IN THE REPORT.

DEFINITION OF TERMS

OUTAGE

The state of a component when it is not available to perform its intended function due to some event directly associated with that component. An outage may or may not cause an interruption of service to consumers depending on the system configuration.

INTERRUPTION

The loss of service to one or more consumers and is a result of one or more component outages.

INTERRUPTION DURATION

The period from the initiation of an interruption to a consumer until service has been restored to that consumer.

MOMENTARY INTERRUPTION

An interruption that has a duration limited to the period required to restore service by automatic or supervisory-controlled switching operations or by manual switching at locations where an operator is immediately available. Such switching operations must be completed in a specific time not to exceed five minutes. Previous issues of this report indicated that a momentary interruption has duration not to exceed one minute. IEEE Std 1366™-2012: IEEE Guide for Electric Power Distribution Reliability Indices indicated that momentary interruptions will have duration of five minutes or less.

SUSTAINED INTERRUPTION

Any interruption not classified as a momentary interruption. Only this type of interruption is included in the reliability indices within this report. In conformance with the guidelines established in the IEEE Std 1366™-2012: IEEE Guide for Electric Power Distribution Reliability Indices, a sustained interruption has duration of over five minutes.

CUSTOMER INTERRUPTION

One interruption of one customer.

NOTE: Interruptions to customers at their request (e.g., customer maintenance) are not considered.

RELIABILITY INDICES

Reliability indices used in this report conform to standards proposed by both the Edison Electric Institute (EEI) and the Institute of Electrical and Electronics Engineers (IEEE) unless otherwise indicated in the above definitions. Five reliability indices that convey a meaningful representation of the level of reliability were selected and are presented in this report. These reliability indices are as follows:

AVERAGE SERVICE AVAILABILITY INDEX (ASAI)

Total customer hours actually served as a percentage of total customer hours possible during the year. This indicates the extent to which electrical service was available to all customers. This index has been commonly referred to as the "Index of Reliability." A customer-hour is calculated by multiplying the number of customers by the number of hours in the period being analyzed.

$$ASAI = \frac{\sum \text{No. of Customer Hours Actually Served During the year}}{\sum No. of\ Customer\ Hours\ Possible\ During\ the\ year} \times 100\%$$

SYSTEM AVERAGE INTERRUPTION FREQUENCY INDEX (SAIFI)

The number of customer interruptions per customer served during the year. This index indicates the average number of sustained interruptions experienced by all customers serviced on the system.

$$SAIFI = \frac{\sum \text{No. of Customer Interruptions Experienced During the year}}{\text{Average No. of Customers Served During the year}}$$

CUSTOMER AVERAGE INTERRUPTION DURATION INDEX (CAIDI)

The interruption duration per customer interrupted during the year. This index indicates the average duration of an interruption for those customers affected by a sustained interruption.

$$CAIDI = \frac{\sum \text{Duration of Interruptions} \times \text{No. of Customers Affected}}{\sum \text{No. of Customer Interruptions Experienced During the year}}$$

SYSTEM AVERAGE INTERRUPTION DURATION INDEX (SAIDI)

The interruption duration per customer served during the year. This index indicates the average interruption time experienced by all customers serviced on the system.

$$SAIDI = \frac{\sum \text{Duration of Interruptions} \times \text{No. of Customers Affected}}{\text{Average No. of Customers Served During the year}}$$

MAUI ELECTRIC COMPANY, LIMITED

ANNUAL SERVICE RELIABILITY REPORT

2018

Prepared by

Asset Management Division

June 3, 2019

INTRODUCTION

This is Maui Electric Company's 2018 annual service reliability report. The average number of electric customers increased from 71,049 in 2017 to 71,671 in 2018 (a 0.88% increase). The 2018 gross peak demand for the system was 210.7 MW on the evening of September 25, 2018, 7.8 MW higher than the gross peak demand of 202.9 MW in 2017; the highest gross system peak demand remains at 210.9 MW set on October 11, 2004, at approximately 6:45 p.m.

The service reliability indices provided in this report are commonly used in the electric power utility industry as a method of measuring system reliability performance. These include overall availability of electrical service (Average Service Availability Index or ASAI), the average frequency or number of times customers experience an interruption of service during the year (System Average Interruption Frequency Index or SAIFI), the average length of time an interrupted customer is out of power (Customer Average Interruption Duration Index or CAIDI), and the average length of time customers are out of power during the year (System Average Interruption Duration Index or SAIDI). SAIDI is an indication of overall system reliability because it incorporates the impact of frequency and duration of outages on the company's total customer base (71,671 customers). The Appendix contains definitions, explanations, and equations for the reliability indices included in this report.

ANALYSIS

The reliability indices provided in this report are calculated using the IEEE Standard 1366-2012 methodology. Indices reported on a normalized basis exclude Major Event Days (MEDs). MEDs are defined as days in which the daily system SAIDI exceeds the MED threshold value (T_{MED}). Statistically, days having a daily system SAIDI greater than T_{MED} indicate days on which the energy delivery system experienced stresses beyond that normally expected (such as during severe weather).[1] In calculating daily system SAIDI, any interruption that spans multiple calendar days is accrued to the day on which the interruption began.

[1] IEEE Std 1366™-2012: IEEE Guide for Electric Power Distribution Reliability Indices.

2018 RESULTS

Annual Service Reliability Indices

The following tables provide reliability index results on a unnormalized and normalized basis for the entire system and separately for 1) transmission and distribution outages, 2) utility generation outages, and 3) non-utility generation outages.

There were four Major Event Days in 2018 that were excluded from the calculation of normalized indices: 8/23/18 due to effects of Hurricane Lane on Maui, 8/24/18 due to effects of Hurricane Lane on Maui, 9/12/18 due to effects of Tropical Storm Olivia on Maui, and 10/20/18 due to an under-frequency load shed (UFLS) due to rapid drop in as-available generation on Maui.

Table 1: Generation, Transmission, and Distribution Outages – All Islands, Unnormalized

	2013	2014	2015	2016	2017	2018
Number of Customers	69,303	69,825	70,303	70,745	71,049	71,671
Customer Interruptions	133,962	175,649	213,736	141,555	248,291	241,217
Customer-Hours Interrupted	220,791	219,072	533,523	220,337	984,239	569,222
SAIDI (Minutes)	191.15	188.25	455.33	186.87	831.18	476.53
CAIDI (Minutes)	98.89	74.83	149.77	93.39	237.84	141.59
SAIFI (Occurrences)	1.933	2.516	3.040	2.001	3.495	3.366
ASAI (Percentage)	99.964%	99.964%	99.913%	99.964%	99.841%	99.909%

Table 2: Generation, Transmission, and Distribution Outages – Maui, Unnormalized

	2013	2014	2015	2016	2017	2018
Number of Customers	64,397	64,909	65,390	65,799	66,107	66,701
Customer Interruptions	95,798	142,271	189,489	118,080	230,067	214,637
Customer-Hours Interrupted	171,107	167,123	504,962	177,695	860,210	462,804
SAIDI (Minutes)	159.43	154.48	463.34	162.03	780.74	416.31
CAIDI (Minutes)	107.17	70.48	159.89	90.29	224.34	129.37
SAIFI (Occurrences)	1.488	2.192	2.898	1.795	3.480	3.218
ASAI (Percentage)	99.970%	99.971%	99.912%	99.969%	99.851%	99.921%

Table 3: Generation, Transmission, and Distribution Outages – Molokai, Unnormalized

	2013	2014	2015	2016	2017	2018
Number of Customers	3,205	3,191	3,193	3,212	3,209	3,232
Customer Interruptions	33,224	21,113	18,192	17,610	12,700	20,101
Customer-Hours Interrupted	44,162	35,756	23,110	38,058	32,315	99,544
SAIDI (Minutes)	826.81	672.23	434.21	710.85	604.19	1847.88
CAIDI (Minutes)	79.75	101.61	76.22	129.67	152.67	297.13
SAIFI (Occurrences)	10.367	6.616	5.697	5.482	3.958	6.219
ASAI (Percentage)	99.842%	99.872%	99.917%	99.865%	99.885%	99.647%

Table 4: Generation, Transmission, and Distribution Outages – Lanai, Unnormalized

	2013	2014	2015	2016	2017	2018
Number of Customers	1,702	1,724	1,720	1,733	1,733	1,738
Customer Interruptions	4,940	12,265	6,055	5,865	5,524	6,479
Customer-Hours Interrupted	5,521	16,192	5,452	4,584	91,714	6,874
SAIDI (Minutes)	194.69	563.46	190.20	158.66	3176.26	237.27
CAIDI (Minutes)	67.06	79.21	54.02	46.89	996.17	63.65
SAIFI (Occurrences)	2.903	7.113	3.521	3.383	3.188	3.727
ASAI (Percentage)	99.963%	99.893%	99.964%	99.970%	99.394%	99.955%

Table 5: Generation, Transmission, and Distribution Outages – All Islands, Normalized [2]

	2013	2014	2015	2016	2017	2018
Number of Customers	69,303	69,825	70,303	70,745	71,049	71,671
Customer Interruptions	110,148	147,964	114,267	113,783	117,429	181,037
Customer-Hours Interrupted	140,770	168,547	157,047	159,383	178,350	272,398
SAIDI (Minutes)	121.87	144.83	134.03	135.18	150.62	228.04
CAIDI (Minutes)	76.68	68.35	82.46	84.05	91.13	90.28
SAIFI (Occurrences)	1.589	2.119	1.625	1.608	1.653	2.526
ASAI (Percentage)	99.977%	99.972%	99.974%	99.974%	99.971%	99.956%

[2] Exclusions include:
- 1/5/13 due to trees or branches in line during high winds on Maui
- 7/29/13 due to effects of Tropical Storm Flossie on Maui
- 7/11/14 due to unknown on company generation on Lanai
- 8/7/14 due to effects of Tropical Storm Iselle on Maui
- 8/8/14 due to effects of Tropical Storm Iselle on Maui
- 10/7/14 due to substation equipment failure on Maui
- 1/2/15 due to Kona Storm on Maui
- 1/3/15 due to Kona Storm on Maui
- 2/14/15 due to Valentine's Day storm on Maui
- 2/24/15 due to unknown and equipment deterioration on Maui
- 11/19/15 due to trees or branches in lines on Maui
- 11/20/15 due to motor vehicle accident and trees or branches in lines on Maui
- 12/18/15 due to substation equipment failure on Maui
- 4/3/16 due to motor vehicle accident on Maui
- 7/2/16 due to West Maui Mountains wild fire on Maui
- 12/18/16 due to trees or branches in lines during high winds on Maui
- 1/21/17 due to high winds on Lanai
- 3/2/17 due to under frequency load shed on Maui
- 10/24/17 due to an island wide outage on Maui
- 11/26/17 due to under frequency load shed and a fault caused by tree branch on Maui
- 8/23/18 due to effects of Hurricane Lane on Maui
- 8/24/18 due to effects of Hurricane Lane on Maui
- 9/12/18 due to effects of Tropical Storm Olivia on Maui
- 10/20/18 under-frequency load shedding (UFLS) due to rapid drop in as-available generation on Maui

Table 6: Generation, Transmission, and Distribution Outages – Maui, Normalized [2]

	2013	2014	2015	2016	2017	2018
Number of Customers	64,397	64,909	65,390	65,799	66,107	66,701
Customer Interruptions	71,984	116,684	90,020	90,308	100,952	154,457
Customer-Hours Interrupted	91,087	120,630	128,486	116,740	143,751	165,980
SAIDI (Minutes)	84.87	111.51	117.89	106.45	130.47	149.31
CAIDI (Minutes)	75.92	62.03	85.64	77.56	85.44	64.48
SAIFI (Occurrences)	1.118	1.798	1.377	1.372	1.527	2.316
ASAI (Percentage)	99.984%	99.979%	99.978%	99.980%	99.975%	99.972%

Table 7: Generation, Transmission, and Distribution Outages – Molokai, Normalized [2]

	2013	2014	2015	2016	2017	2018
Number of Customers	3,205	3,191	3,193	3,212	3,209	3,232
Customer Interruptions	33,224	21,113	18,192	17,610	12,700	20,101
Customer-Hours Interrupted	44,162	35,756	23,110	38,058	32,315	99,544
SAIDI (Minutes)	826.81	672.23	434.21	710.85	604.19	1847.88
CAIDI (Minutes)	79.75	101.61	76.22	129.67	152.67	297.13
SAIFI (Occurrences)	10.367	6.616	5.697	5.482	3.958	6.219
ASAI (Percentage)	99.842%	99.872%	99.917%	99.865%	99.885%	99.647%

Table 8: Generation, Transmission, and Distribution Outages – Lanai, Normalized [2]

	2013	2014	2015	2016	2017	2018
Number of Customers	1,702	1,724	1,720	1,733	1,733	1,738
Customer Interruptions	4,940	10,167	6,055	5,865	3,777	6,479
Customer-Hours Interrupted	5,521	12,161	5,452	4,584	2,284	6,874
SAIDI (Minutes)	194.69	423.19	190.20	158.66	79.10	237.27
CAIDI (Minutes)	67.06	71.77	54.02	46.89	36.28	63.65
SAIFI (Occurrences)	2.903	5.896	3.521	3.383	2.180	3.727
ASAI (Percentage)	99.963%	99.919%	99.964%	99.970%	99.985%	99.955%

Table 9: Transmission and Distribution Outages – All Islands, Unnormalized

	2013	2014	2015	2016	2017	2018
Number of Customers	69,303	69,825	70,303	70,745	71,049	71,671
Customer Interruptions	111,567	151,460	185,384	134,247	244,444	173,292
Customer-Hours Interrupted	199,448	198,364	515,672	213,140	979,851	527,947
SAIDI (Minutes)	172.67	170.45	440.10	180.77	827.48	441.98
CAIDI (Minutes)	107.26	78.58	166.90	95.26	240.51	182.79
SAIFI (Occurrences)	1.610	2.169	2.637	1.898	3.441	2.418
ASAI (Percentage)	99.967%	99.967%	99.916%	99.966%	99.842%	99.916%

Table 10: Utility Generation Outages – All Islands, Unnormalized

	2013	2014	2015	2016	2017	2018
Number of Customers	69,303	69,825	70,303	70,745	71,049	71,671
Customer Interruptions	19,670	17,788	12,044	7,305	3,667	23,563
Customer-Hours Interrupted	20,578	16,038	14,148	7,185	4,296	17,010
SAIDI (Minutes)	17.82	13.78	12.07	6.09	3.63	14.24
CAIDI (Minutes)	62.77	54.10	70.48	59.01	70.29	43.31
SAIFI (Occurrences)	0.284	0.255	0.171	0.103	0.052	0.329
ASAI (Percentage)	99.997%	99.997%	99.998%	99.999%	99.999%	99.997%

Table 11: Non-Utility Generation Outages – All Islands, Unnormalized

	2013	2014	2015	2016	2017	2018
Number of Customers	69,303	69,825	70,303	70,745	71,049	71,671
Customer Interruptions	2,725	6,401	16,308	3	180	44,362
Customer-Hours Interrupted	765	4,671	3,704	13	92	24,264
SAIDI (Minutes)	0.66	4.01	3.16	0.01	0.08	20.31
CAIDI (Minutes)	16.84	43.78	13.63	255.00	30.71	32.82
SAIFI (Occurrences)	0.039	0.092	0.232	0.000	0.003	0.619
ASAI (Percentage)	100.000%	99.999%	99.999%	100.000%	100.000%	99.996%

Table 12: Transmission and Distribution Outages – Maui, Unnormalized

	2013	2014	2015	2016	2017	2018
Number of Customers	64,397	64,909	65,390	65,799	66,107	66,701
Customer Interruptions	90,348	128,824	168,666	118,077	230,067	152,495
Customer-Hours Interrupted	169,303	159,788	493,409	177,682	860,210	426,968
SAIDI (Minutes)	157.74	147.70	452.74	162.02	780.74	384.08
CAIDI (Minutes)	112.43	74.42	175.52	90.29	224.34	167.99
SAIFI (Occurrences)	1.403	1.985	2.579	1.795	3.480	2.286
ASAI (Percentage)	99.970%	99.972%	99.914%	99.969%	99.851%	99.927%

Table 13: Utility Generation Outages – Maui, Unnormalized

	2013	2014	2015	2016	2017	2018
Number of Customers	64,397	64,909	65,390	65,799	66,107	66,701
Customer Interruptions	2,725	7,046	4,515	0	0	17,960
Customer-Hours Interrupted	1,040	2,665	7,849	0	0	11,658
SAIDI (Minutes)	0.97	2.46	7.20	0.00	0.00	10.49
CAIDI (Minutes)	22.89	22.69	104.30	0.00	0.00	38.95
SAIFI (Occurrences)	0.042	0.109	0.069	0.000	0.000	0.269
ASAI (Percentage)	100.000%	100.000%	99.999%	100.000%	100.000%	99.998%

Table 14: Non-Utility Generation Outages – Maui, Unnormalized

	2013	2014	2015	2016	2017	2018
Number of Customers	64,397	64,909	65,390	65,799	66,107	66,701
Customer Interruptions	2,725	6,401	16,308	3	0	44,182
Customer-Hours Interrupted	765	4,671	3,704	13	0	24,178
SAIDI (Minutes)	0.71	4.32	3.40	0.01	0.00	21.75
CAIDI (Minutes)	16.84	43.78	13.63	255.00	0.00	32.83
SAIFI (Occurrences)	0.042	0.099	0.249	0.000	0.000	0.662
ASAI (Percentage)	100.000%	99.999%	99.999%	100.000%	100.000%	99.996%

Table 15: Transmission and Distribution Outages – Molokai, Unnormalized

	2013	2014	2015	2016	2017	2018
Number of Customers	3,205	3,191	3,193	3,212	3,209	3,232
Customer Interruptions	16,288	18,189	14,373	15,259	10,952	17,177
Customer-Hours Interrupted	24,624	32,790	19,415	34,985	29,132	96,584
SAIDI (Minutes)	461.02	616.46	364.79	653.46	544.68	1792.93
CAIDI (Minutes)	90.71	108.16	81.05	137.57	159.60	337.37
SAIFI (Occurrences)	5.082	5.699	4.501	4.750	3.413	5.314
ASAI (Percentage)	99.912%	99.882%	99.930%	99.876%	99.896%	99.658%

Table 16: Utility Generation Outages – Molokai, Unnormalized

	2013	2014	2015	2016	2017	2018
Number of Customers	3,205	3,191	3,193	3,212	3,209	3,232
Customer Interruptions	16,936	2,924	3,819	2,351	1,748	2,924
Customer-Hours Interrupted	19,538	2,966	3,695	3,073	3,183	2,960
SAIDI (Minutes)	365.79	55.77	69.42	57.40	59.51	54.94
CAIDI (Minutes)	69.22	60.87	58.05	78.42	109.26	60.74
SAIFI (Occurrences)	5.285	0.916	1.196	0.732	0.545	0.905
ASAI (Percentage)	99.930%	99.989%	99.987%	99.989%	99.989%	99.990%

Table 17: Non-Utility Generation Outages – Molokai, Unnormalized

	2013	2014	2015	2016	2017	2018
Number of Customers	3,205	3,191	3,193	3,212	3,209	3,232
Customer Interruptions	0	0	0	0	0	0
Customer-Hours Interrupted	0	0	0	0	0	0
SAIDI (Minutes)	0.00	0.00	0.00	0.00	0.00	0.00
CAIDI (Minutes)	0.00	0.00	0.00	0.00	0.00	0.00
SAIFI (Occurrences)	0.000	0.000	0.000	0.000	0.000	0.000
ASAI (Percentage)	100.000%	100.000%	100.000%	100.000%	100.000%	100.000%

Table 18: Transmission and Distribution Outages – Lanai, Unnormalized

	2013	2014	2015	2016	2017	2018
Number of Customers	1,702	1,724	1,720	1,733	1,733	1,738
Customer Interruptions	4,931	4,447	2,345	911	3,425	3,620
Customer-Hours Interrupted	5,521	5,786	2,848	472	90,510	4,395
SAIDI (Minutes)	194.66	201.34	99.35	16.35	3134.53	151.71
CAIDI (Minutes)	67.17	78.07	72.86	31.10	1585.57	72.85
SAIFI (Occurrences)	2.898	2.579	1.364	0.526	1.977	2.083
ASAI (Percentage)	99.963%	99.962%	99.981%	99.997%	99.402%	99.971%

Table 19: Utility Generation Outages – Lanai, Unnormalized

	2013	2014	2015	2016	2017	2018
Number of Customers	1,702	1,724	1,720	1,733	1,733	1,738
Customer Interruptions	9	7,818	3,710	4,954	1,919	2,679
Customer-Hours Interrupted	1	10,406	2,604	4,112	1,113	2,392
SAIDI (Minutes)	0.03	362.12	90.85	142.32	38.53	82.58
CAIDI (Minutes)	6.33	79.86	42.11	49.80	34.79	53.58
SAIFI (Occurrences)	0.005	4.534	2.157	2.858	1.108	1.541
ASAI (Percentage)	100.000%	99.931%	99.983%	99.973%	99.993%	99.984%

Table 20: Non-Utility Generation Outages – Lanai, Unnormalized

	2013	2014	2015	2016	2017	2018
Number of Customers	1,702	1,724	1,720	1,733	1,733	1,738
Customer Interruptions	0	0	0	0	180	180
Customer-Hours Interrupted	0	0	0	0	92	86
SAIDI (Minutes)	0.00	0.00	0.00	0.00	3.19	2.98
CAIDI (Minutes)	0.00	0.00	0.00	0.00	30.71	28.75
SAIFI (Occurrences)	0.000	0.000	0.000	0.000	0.104	0.104
ASAI (Percentage)	100.000%	100.000%	100.000%	100.000%	99.999%	99.999%

Table 21: Transmission and Distribution Outages - All Islands, Normalized[2]

	2013	2014	2015	2016	2017	2018
Number of Customers	69,303	69,825	70,303	70,745	71,049	71,671
Customer Interruptions	87,753	125,715	86,481	106,475	113,582	135,488
Customer-Hours Interrupted	119,427	151,862	144,209	152,185	173,962	248,682
SAIDI (Minutes)	103.40	130.49	123.07	129.07	146.91	208.19
CAIDI (Minutes)	81.66	72.48	100.05	85.76	91.90	110.13
SAIFI (Occurrences)	1.266	1.800	1.230	1.505	1.599	1.890
ASAI (Percentage)	99.980%	99.975%	99.977%	99.975%	99.972%	99.960%

Table 22: Utility Generation Outages - All Islands, Normalized[2]

	2013	2014	2015	2016	2017	2018
Number of Customers	69,303	69,825	70,303	70,745	71,049	71,671
Customer Interruptions	19,670	15,848	11,478	7,305	3,667	23,563
Customer-Hours Interrupted	20,578	12,015	9,134	7,185	4,296	17,010
SAIDI (Minutes)	17.82	10.32	7.79	6.09	3.63	14.24
CAIDI (Minutes)	62.77	45.49	47.74	59.01	70.29	43.31
SAIFI (Occurrences)	0.284	0.227	0.163	0.103	0.052	0.329
ASAI (Percentage)	99.997%	99.998%	99.999%	99.999%	99.999%	99.997%

Table 23: Non-Utility Generation Outages – All Islands, Normalized[2]

	2013	2014	2015	2016	2017	2018
Number of Customers	69,303	69,825	70,303	70,745	71,049	71,671
Customer Interruptions	2,725	6,401	16,308	3	180	21,986
Customer-Hours Interrupted	765	4,671	3,704	13	92	6,706
SAIDI (Minutes)	0.66	4.01	3.16	0.01	0.08	5.61
CAIDI (Minutes)	16.84	43.78	13.63	255.00	30.71	18.30
SAIFI (Occurrences)	0.039	0.092	0.232	0.000	0.003	0.307
ASAI (Percentage)	100.000%	99.999%	99.999%	100.000%	100.000%	99.999%

Table 24: Transmission and Distribution Outages – Maui, Normalized[2]

	2013	2014	2015	2016	2017	2018
Number of Customers	64,397	64,909	65,390	65,799	66,107	66,701
Customer Interruptions	66,534	103,457	69,763	90,305	100,952	114,691
Customer-Hours Interrupted	89,282	113,324	121,947	116,728	143,751	147,702
SAIDI (Minutes)	83.19	104.75	111.89	106.44	130.47	132.86
CAIDI (Minutes)	80.51	65.72	104.88	77.56	85.44	77.27
SAIFI (Occurrences)	1.033	1.594	1.067	1.372	1.527	1.719
ASAI (Percentage)	99.984%	99.980%	99.979%	99.980%	99.975%	99.975%

Table 25: Utility Generation Outages – Maui, Normalized[2]

	2013	2014	2015	2016	2017	2018
Number of Customers	64,397	64,909	65,390	65,799	66,107	66,701
Customer Interruptions	2,725	6,826	3,949	0	0	17,960
Customer-Hours Interrupted	1,040	2,636	2,835	0	0	11,658
SAIDI (Minutes)	0.97	2.44	2.60	0.00	0.00	10.49
CAIDI (Minutes)	22.89	23.17	43.07	0.00	0.00	38.95
SAIFI (Occurrences)	0.042	0.105	0.060	0.000	0.000	0.269
ASAI (Percentage)	100.000%	100.000%	100.000%	100.000%	100.000%	99.998%

Table 26: Non-Utility Generation Outages – Maui, Normalized[2]

	2013	2014	2015	2016	2017	2018
Number of Customers	64,397	64,909	65,390	65,799	66,107	66,701
Customer Interruptions	2,725	6,401	16,308	3	0	21,806
Customer-Hours Interrupted	765	4,671	3,704	13	0	6,620
SAIDI (Minutes)	0.71	4.32	3.40	0.01	0.00	5.96
CAIDI (Minutes)	16.84	43.78	13.63	255.00	0.00	18.22
SAIFI (Occurrences)	0.042	0.099	0.249	0.000	0.000	0.327
ASAI (Percentage)	100.000%	99.999%	99.999%	100.000%	100.000%	99.999%

Table 27: Transmission and Distribution Outages – Molokai, Normalized[2]

	2013	2014	2015	2016	2017	2018
Number of Customers	3,205	3,191	3,193	3,212	3,209	3,232
Customer Interruptions	16,288	18,189	14,373	15,259	10,952	17,177
Customer-Hours Interrupted	24,624	32,790	19,415	34,985	29,132	96,584
SAIDI (Minutes)	461.02	616.46	364.79	653.46	544.68	1792.93
CAIDI (Minutes)	90.71	108.16	81.05	137.57	159.60	337.37
SAIFI (Occurrences)	5.082	5.699	4.501	4.750	3.413	5.314
ASAI (Percentage)	99.912%	99.882%	99.930%	99.876%	99.896%	99.658%

Table 28: Utility Generation Outages – Molokai, Normalized[2]

	2013	2014	2015	2016	2017	2018
Number of Customers	3,205	3,191	3,193	3,212	3,209	3,232
Customer Interruptions	16,936	2,924	3,819	2,351	1,748	2,924
Customer-Hours Interrupted	19,538	2,966	3,695	3,073	3,183	2,960
SAIDI (Minutes)	365.79	55.77	69.42	57.40	59.51	54.94
CAIDI (Minutes)	69.22	60.87	58.05	78.42	109.26	60.74
SAIFI (Occurrences)	5.285	0.916	1.196	0.732	0.545	0.905
ASAI (Percentage)	99.930%	99.989%	99.987%	99.989%	99.989%	99.990%

Table 29: Non-Utility Generation Outages – Molokai, Normalized[2]

	2013	2014	2015	2016	2017	2018
Number of Customers	3,205	3,191	3,193	3,212	3,209	3,232
Customer Interruptions	0	0	0	0	0	0
Customer-Hours Interrupted	0	0	0	0	0	0
SAIDI (Minutes)	0.00	0.00	0.00	0.00	0.00	0.00
CAIDI (Minutes)	0.00	0.00	0.00	0.00	0.00	0.00
SAIFI (Occurrences)	0.000	0.000	0.000	0.000	0.000	0.000
ASAI (Percentage)	100.000%	100.000%	100.000%	100.000%	100.000%	100.000%

Table 30: Transmission and Distribution Outages – Lanai, Normalized[2]

	2013	2014	2015	2016	2017	2018
Number of Customers	1,702	1,724	1,720	1,733	1,733	1,738
Customer Interruptions	4,931	4,069	2,345	911	1,678	3,620
Customer-Hours Interrupted	5,521	5,748	2,848	472	1,079	4,395
SAIDI (Minutes)	194.66	200.03	99.35	16.35	37.38	151.71
CAIDI (Minutes)	67.17	84.76	72.86	31.10	38.59	72.85
SAIFI (Occurrences)	2.898	2.360	1.364	0.526	0.969	2.083
ASAI (Percentage)	99.963%	99.962%	99.981%	99.997%	99.993%	99.971%

Table 31: Utility Generation Outages – Lanai, Normalized[2]

	2013	2014	2015	2016	2017	2018
Number of Customers	1,702	1,724	1,720	1,733	1,733	1,738
Customer Interruptions	9	6,098	3,710	4,954	1,919	2,679
Customer-Hours Interrupted	1	6,413	2,604	4,112	1,113	2,392
SAIDI (Minutes)	0.03	223.16	90.85	142.32	38.53	82.58
CAIDI (Minutes)	6.33	63.10	42.11	49.80	34.79	53.58
SAIFI (Occurrences)	0.005	3.537	2.157	2.858	1.108	1.541
ASAI (Percentage)	100.000%	99.957%	99.983%	99.973%	99.993%	99.984%

Table 32: Non-Utility Generation Outages – Lanai, Normalized[2]

	2013	2014	2015	2016	2017	2018
Number of Customers	1,702	1,724	1,720	1,733	1,733	1,738
Customer Interruptions	0	0	0	0	180	180
Customer-Hours Interrupted	0	0	0	0	92	86
SAIDI (Minutes)	0.00	0.00	0.00	0.00	3.19	2.98
CAIDI (Minutes)	0.00	0.00	0.00	0.00	30.71	28.75
SAIFI (Occurrences)	0.000	0.000	0.000	0.000	0.104	0.104
ASAI (Percentage)	100.000%	100.000%	100.000%	100.000%	99.999%	99.999%

The following charts and discussion are based on the reliability index results for generation, transmission, and distribution outages on a normalized basis (data from Table 5 above).

Figure 1: System Average Interruption Duration Index (SAIDI)

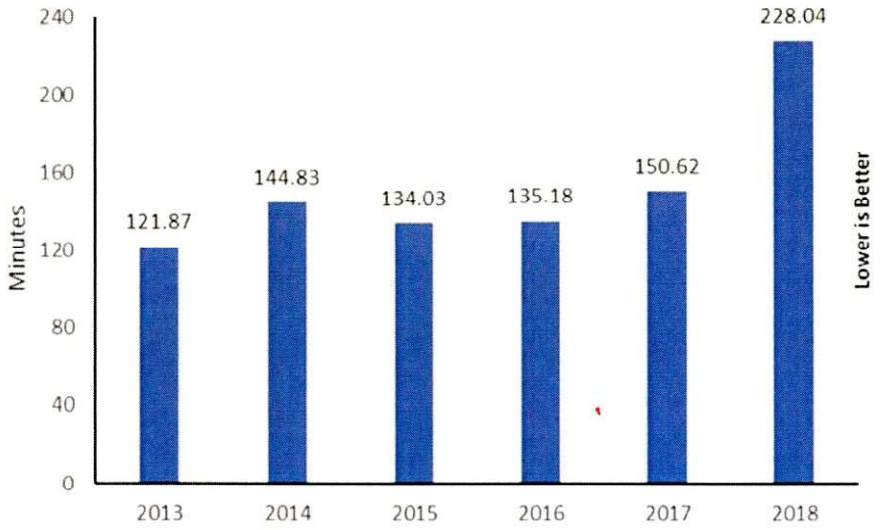


Figure 1 shows the SAIDI values for 2013-2018.

The 2018 SAIDI is 228.04 minutes, a 51% increase compared to the 2017 SAIDI result of 150.62 minutes. The customer hours interrupted was 272,398 in 2018 compared to 178,350 in 2017. In the past six years, 2018 had the most customer hours interrupted.

The following events significantly impacted the 2018 SAIDI result:

1. September 12, 2018 (Wednesday) – The effects of Tropical Storm Olivia on Molokai affected 1,474 customers from 4 hours and 12 minutes up to 37 hours and 14 minutes. This event contributed 21.73 minutes to SAIDI.
2. June 26, 2018 (Tuesday) – A sheet of roofing caused downed conductors, resulting in generation to trip off-line and an island-wide blackout on Molokai. This affected 3,229 customers from 6 hours and 42 minutes up to 11 hours and 40 minutes. This event contributed 21.36 minutes to SAIDI.
3. August 23 to August 24, 2018 (Thursday to Friday) – The effects of Hurricane Lane on Molokai affected 2,160 customers from 2 hours and 32 minutes up to 10 hours and 8 minutes. This event contributed 11.91 minutes to SAIDI.
4. November 18, 2018 (Sunday) – A static wire broke and draped over conductors on Piilani Highway on Maui. This affected 7,413 customers from a momentary interruption up to 4 hours and 6 minutes. This event contributed 7.79 minutes to SAIDI.

Figure 2: System Average Interruption Frequency Index (SAIFI)

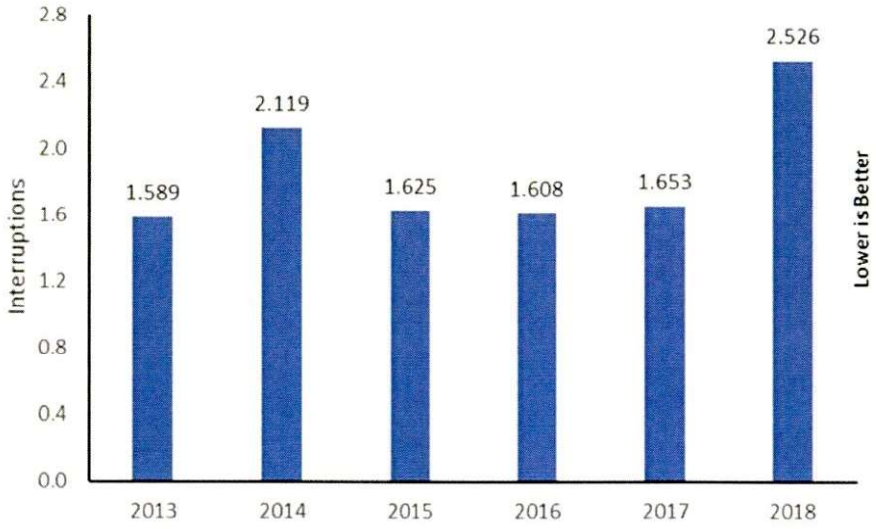


Figure 2 shows the SAIFI values for 2013-2018.

The 2018 SAIFI of 2.526 is a 53% increase compared to the 2017 SAIFI result of 1.653. The number of customer interruptions in 2018 was 181,037 as compared to 117,429 customer interruptions in 2017. In the past six years, 2018 had the most customer interruptions.

The following events significantly impacted the 2018 SAIFI result:

1. October 27, 2018 (Saturday) – Under-frequency load shed (UFLS) due to a rapid drop in as-available generation on Maui. This affected 22,376 customers from a momentary interruption up to 1 hour and 15 minutes. This event contributed 0.300 to SAIFI.
2. April 20, 2018 (Friday) – A generation issue resulted in an UFLS event on Maui. This affected 15,864 customers from a momentary interruption up to 3 hours and 32 minutes. This event contributed 0.220 to SAIFI.
3. March 20, 2018 (Tuesday) – A blown substation transformer pothead caused a transmission line to de-energize on Maui. This affected 9,756 customers from 22 minutes up to 1 hour and 12 minutes. This event contributed 0.140 to SAIFI.

Figure 3: Customer Average Interruption Duration Index (CAIDI)

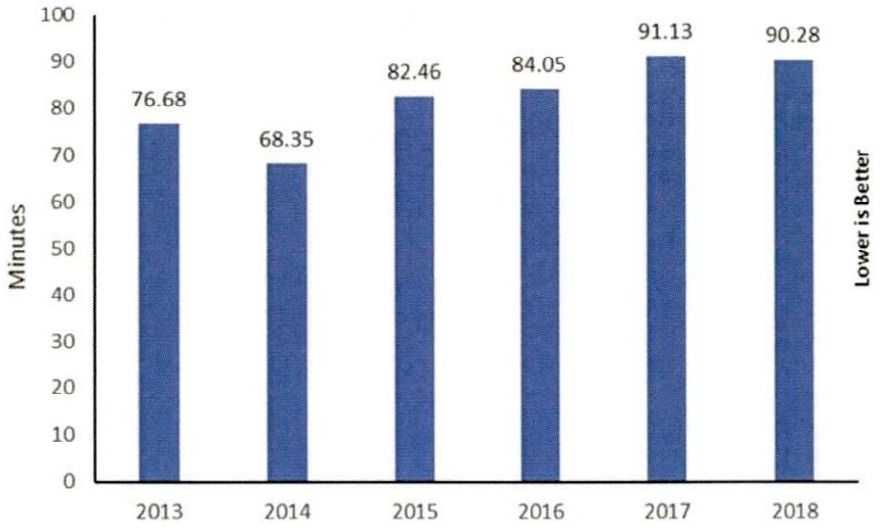


Figure 3 shows the CAIDI values for 2013-2018.

The 2018 CAIDI of 90.28 minutes is a 0.9% decrease compared to the 2017 CAIDI of 91.13 minutes.

The following events significantly affected the 2018 CAIDI results:

1. September 12, 2018 (Wednesday) – The effects of Tropical Storm Olivia on Molokai affected 1,474 customers from 4 hours and 12 minutes up to 37 hours and 14 minutes. This event contributed 7.93 minutes to CAIDI.
2. June 26, 2018 (Tuesday) – A sheet of roofing caused downed conductors, resulting in generation to trip off-line and an island-wide blackout on Molokai. This affected 3,229 customers from 6 hours and 42 minutes up to 11 hours and 40 minutes. This event contributed 6.97 minutes to CAIDI.
3. August 23 to August 24, 2018 (Thursday to Friday) – The effects of Hurricane Lane on Molokai affected 2,160 customers from 2 hours and 32 minutes up to 10 hours and 8 minutes. This event contributed 3.68 minutes to CAIDI.

Figure 4: Average System Availability Index (ASAI)

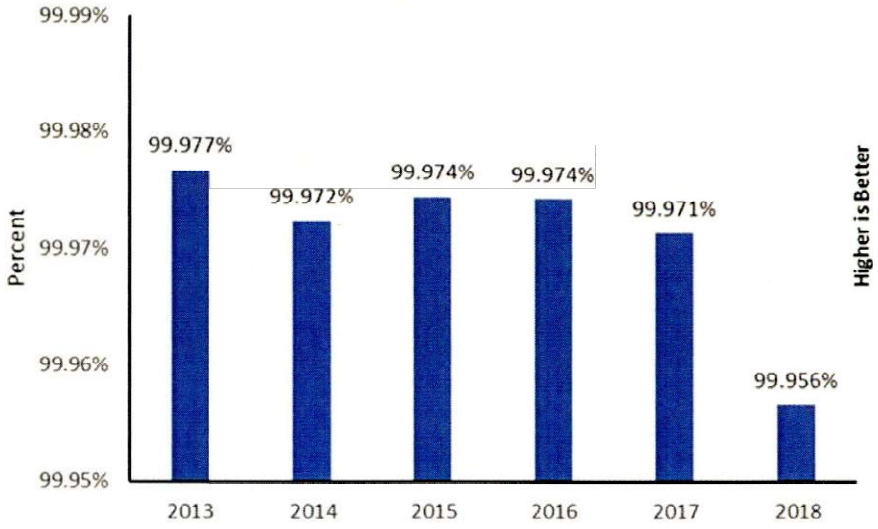
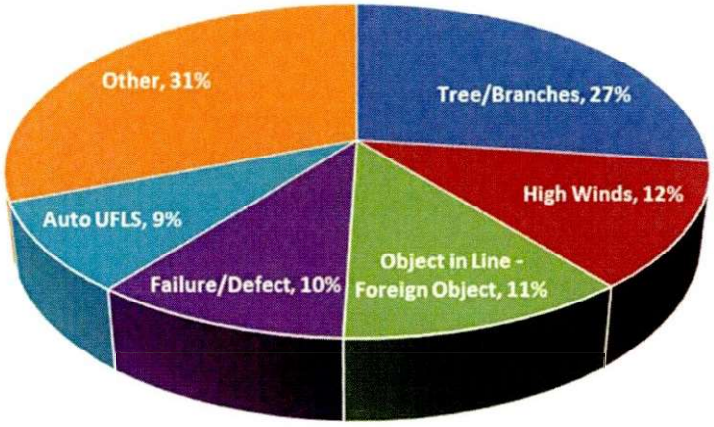


Figure 4 shows the ASAI values for 2013-2018.

The 2018 ASAI of 99.956% is a 0.015% decrease compared to the 2017 ASAI of 99.971%. This is the lowest ASAI of the last six years. The customer hours interrupted was 272,398 hours in 2018 compared to 178,350 hours in 2017.

Figure 5: Outage Causes for 2018



The top five outage causes by customer hours interrupted, as illustrated in Figure 5, accounted for 69% of the total customer hours interrupted in 2018. These include:

	Top Outage Cause	Description
1.	Tree/Branches	Vegetation contacting or falling onto overhead conductors
2.	High Winds	Broken equipment due to high winds
3.	Object in Line – Foreign Object	Debris contacting overhead lines
4.	Failure/Defect	Defective equipment failing in-service
5.	Tree	Trees falling on or contacting overhead lines

From 2017 to 2018, Trees/Branches remained the top outage cause and High Winds went from 4th to 2nd. Equipment Deterioration and Cable Fault were replaced in the top five by Object in Line – Foreign Object, Failure/Defect, and Auto UFLS.

Maui Electric Company
Normalized Sustained Interruption Summary – System Total

FROM: JANUARY 1, 2018 **TO:** DECEMBER 31, 2018

Outage Cause	Customer Hours	Customer Interruptions	SAIFI	SAIDI	CAIDI
Tree/Branches	73,568.23	33,588	0.469	61.59	131.42
High Winds	33,216.00	11,921	0.166	27.81	167.18
Object in Line - Foreign Object	30,818.12	6,808	0.095	25.80	271.61
Failure/Defect	27,194.68	22,920	0.320	22.77	71.19
Auto UFLS	23,630.12	45,369	0.633	19.78	31.25
Deterioration/Corrosion	18,403.65	12,860	0.179	15.41	85.86
Accident - Auto	14,719.80	6,528	0.091	12.32	135.29
Cable Fault	8,855.17	8,219	0.115	7.41	64.64
Lightning	7,097.03	468	0.007	5.94	909.88
Object in Line - Animal	6,821.33	3,013	0.042	5.71	135.84
Forced	4,890.65	7,490	0.105	4.09	39.18
Unknown	4,871.30	2,959	0.041	4.08	98.78
Scheduled	4,293.13	1,743	0.024	3.59	147.78
Overgrown	4,101.55	4,412	0.062	3.43	55.78
Transformer - Failure	2,825.33	513	0.007	2.37	330.45
Flashover	2,764.65	3,408	0.048	2.31	48.67
Accident - Other	2,006.33	2,374	0.033	1.68	50.71
Overload	893.25	782	0.011	0.75	68.54
Other Company Personnel	412.18	3,711	0.052	0.35	6.66
Accident - Construction	373.70	448	0.006	0.31	50.05
Vandalism	293.60	1,101	0.015	0.25	16.00
Fire	153.92	60	0.001	0.13	153.92
Customer - Equipment	102.95	188	0.003	0.09	32.86
Transformer - Overload	39.05	22	0.000	0.03	106.50
Other	20.67	20	0.000	0.02	62.00
Object in Line - Balloon	20.37	94	0.001	0.02	13.00
System Change	8.25	3	0.000	0.01	165.00
Switching	2.88	15	0.000	0.00	11.53
Customer - Request	0.00	0	0.000	0.00	0.00
Faulty Operation	0.00	0	0.000	0.00	0.00
Flooding	0.00	0	0.000	0.00	0.00
Heavy Rain	0.00	0	0.000	0.00	0.00
Landslide	0.00	0	0.000	0.00	0.00
Manual Load Shed	0.00	0	0.000	0.00	0.00
Natural Disaster/Tsunami/Earthquake	0.00	0	0.000	0.00	0.00
Object in Line - Man	0.00	0	0.000	0.00	0.00
TOTAL	**272,397.90**	**181,037**	**2.526**	**228.04**	**90.28**

AVERAGE SYSTEM AVAILABILITY =	99.956%
NUMBER OF CUSTOMERS FOR THE PERIOD =	71,671
24 MONTH ANNUALIZED SAIDI AVERAGE FOR THE PERIOD 1/1/2017 - 12/31/2018 =	189.50
24 MONTH AVERAGE NUMBER OF CUSTOMERS FOR THE PERIOD 1/1/2017 - 12/31/2018 =	71,360

NOTES: OUTAGE CAUSES ARE LISTED IN ORDER OF SAIDI.
OUTAGES WITH ZERO CUSTOMER HOURS OR DUE TO CUSTOMER MAINTENANCE ARE NOT INCLUDED IN THE REPORT.

Maui Electric Company
Normalized Sustained Interruption Summary – Maui

FROM: JANUARY 1, 2018 **TO:** DECEMBER 31, 2018

Outage Cause	Customer Hours	Customer Interruptions	SAIFI	SAIDI	CAIDI
Tree/Branches	50,568.85	30,502	0.457	45.49	99.47
Failure/Defect	27,185.88	22,918	0.344	24.45	71.17
Auto UFLS	18,277.97	39,766	0.596	16.44	27.58
Deterioration/Corrosion	14,862.60	11,064	0.166	13.37	80.60
Accident - Auto	12,228.90	6,114	0.092	11.00	120.01
High Winds	7,137.35	7,732	0.116	6.42	55.39
Object in Line - Foreign Object	5,295.42	3,573	0.054	4.76	88.92
Cable Fault	5,202.38	6,631	0.099	4.68	47.07
Object in Line - Animal	4,595.27	1,925	0.029	4.13	143.23
Scheduled	4,211.20	1,737	0.026	3.79	145.46
Overgrown	3,889.53	4,264	0.064	3.50	54.73
Forced	3,283.50	6,548	0.098	2.95	30.09
Flashover	2,764.65	3,408	0.051	2.49	48.67
Transformer - Failure	2,145.83	255	0.004	1.93	504.90
Unknown	1,069.63	1,167	0.017	0.96	54.99
Lightning	990.90	147	0.002	0.89	404.45
Accident - Other	925.40	1,236	0.019	0.83	44.92
Other Company Personnel	397.68	3,702	0.056	0.36	6.45
Accident - Construction	329.70	433	0.006	0.30	45.69
Vandalism	293.60	1,101	0.017	0.26	16.00
Fire	153.92	60	0.001	0.14	153.92
Overload	82.95	29	0.000	0.07	171.62
Transformer - Overload	39.05	22	0.000	0.04	106.50
Other	20.67	20	0.000	0.02	62.00
Object in Line - Balloon	20.37	94	0.001	0.02	13.00
Customer - Equipment	5.60	2	0.000	0.01	168.00
Switching	1.28	7	0.000	0.00	11.00
Customer - Request	0.00	0	0.000	0.00	0.00
Faulty Operation	0.00	0	0.000	0.00	0.00
Flooding	0.00	0	0.000	0.00	0.00
Heavy Rain	0.00	0	0.000	0.00	0.00
Landslide	0.00	0	0.000	0.00	0.00
Manual Load Shed	0.00	0	0.000	0.00	0.00
Natural Disaster/Tsunami/Earthquake	0.00	0	0.000	0.00	0.00
Object in Line - Man	0.00	0	0.000	0.00	0.00
System Change	0.00	0	0.000	0.00	0.00
TOTAL	**165,980.08**	**154,457**	**2.316**	**149.31**	**64.48**

AVERAGE SYSTEM AVAILABILITY =	99.972%
NUMBER OF CUSTOMERS FOR THE PERIOD =	66,701
24 MONTH ANNUALIZED SAIDI AVERAGE FOR THE PERIOD 1/1/2017 - 12/31/2018 =	139.93
24 MONTH AVERAGE NUMBER OF CUSTOMERS FOR THE PERIOD 1/1/2017 - 12/31/2018 =	66,404

NOTES: OUTAGE CAUSES ARE LISTED IN ORDER OF SAIDI.
OUTAGES WITH ZERO CUSTOMER HOURS OR DUE TO CUSTOMER MAINTENANCE ARE NOT INCLUDED IN THE REPORT.

Maui Electric Company
Normalized Sustained Interruption Summary – Molokai

FROM: JANUARY 1, 2018 **TO:** DECEMBER 31, 2018

Outage Cause	Customer Hours	Customer Interruptions	SAIFI	SAIDI	CAIDI
High Winds	26,078.65	4,189	1.296	484.11	373.53
Object in Line - Foreign Object	25,515.22	3,229	0.999	473.65	474.11
Tree/Branches	22,980.28	3,083	0.954	426.59	447.23
Lightning	6,081.45	309	0.096	112.89	1180.86
Cable Fault	3,652.78	1,588	0.491	67.81	138.01
Unknown	3,331.55	1,023	0.317	61.84	195.40
Auto UFLS	2,959.83	2,924	0.905	54.94	60.74
Accident - Auto	2,490.90	414	0.128	46.24	361.00
Object in Line - Animal	2,116.17	995	0.308	39.28	127.61
Deterioration/Corrosion	1,390.08	517	0.160	25.80	161.32
Forced	1,261.55	669	0.207	23.42	113.14
Overload	810.30	753	0.233	15.04	64.57
Transformer - Failure	679.50	258	0.080	12.61	158.02
Overgrown	176.00	142	0.044	3.27	74.37
Customer - Equipment	11.10	6	0.002	0.21	111.00
Failure/Defect	8.80	2	0.001	0.16	264.00
Accident - Construction	0.00	0	0.000	0.00	0.00
Accident - Other	0.00	0	0.000	0.00	0.00
Customer - Request	0.00	0	0.000	0.00	0.00
Faulty Operation	0.00	0	0.000	0.00	0.00
Fire	0.00	0	0.000	0.00	0.00
Flashover	0.00	0	0.000	0.00	0.00
Flooding	0.00	0	0.000	0.00	0.00
Heavy Rain	0.00	0	0.000	0.00	0.00
Landslide	0.00	0	0.000	0.00	0.00
Manual Load Shed	0.00	0	0.000	0.00	0.00
Natural Disaster/Tsunami/Earthquake	0.00	0	0.000	0.00	0.00
Object in Line - Balloon	0.00	0	0.000	0.00	0.00
Object in Line - Man	0.00	0	0.000	0.00	0.00
Other	0.00	0	0.000	0.00	0.00
Other Company Personnel	0.00	0	0.000	0.00	0.00
Scheduled	0.00	0	0.000	0.00	0.00
Switching	0.00	0	0.000	0.00	0.00
System Change	0.00	0	0.000	0.00	0.00
Transformer - Overload	0.00	0	0.000	0.00	0.00
Vandalism	0.00	0	0.000	0.00	0.00
TOTAL	**99,544.17**	**20,101**	**6.219**	**1847.88**	**297.13**

AVERAGE SYSTEM AVAILABILITY =	99.647%
NUMBER OF CUSTOMERS FOR THE PERIOD =	3,232
24 MONTH ANNUALIZED SAIDI AVERAGE FOR THE PERIOD 1/1/2017 - 12/31/2018 =	1228.26
24 MONTH AVERAGE NUMBER OF CUSTOMERS FOR THE PERIOD 1/1/2017- 12/31/2018 =	3,221

NOTES: OUTAGE CAUSES ARE LISTED IN ORDER OF SAIDI.
OUTAGES WITH ZERO CUSTOMER HOURS OR DUE TO CUSTOMER MAINTENANCE ARE NOT INCLUDED IN THE REPORT.

Maui Electric Company
Normalized Sustained Interruption Summary – Lanai

FROM: JANUARY 1, 2018 **TO:** DECEMBER 31, 2018

Outage Cause	Customer Hours	Customer Interruptions	SAIFI	SAIDI	CAIDI
Auto UFLS	2,392.32	2,679	1.541	82.58	53.58
Deterioration/Corrosion	2,150.97	1,279	0.736	74.25	100.91
Accident - Other	1,080.93	1,138	0.655	37.31	56.99
Unknown	470.12	769	0.442	16.23	36.68
Forced	345.60	273	0.157	11.93	75.96
Object in Line - Animal	109.90	93	0.054	3.79	70.90
Customer - Equipment	86.25	180	0.104	2.98	28.75
Scheduled	81.93	6	0.003	2.83	819.33
Accident - Construction	44.00	15	0.009	1.52	176.00
Overgrown	36.02	6	0.003	1.24	360.17
Lightning	24.68	12	0.007	0.85	123.42
Tree/Branches	19.10	3	0.002	0.66	382.00
Other Company Personnel	14.50	9	0.005	0.50	96.67
System Change	8.25	3	0.002	0.28	165.00
Object in Line - Foreign Object	7.48	6	0.003	0.26	74.83
Switching	1.60	8	0.005	0.06	12.00
Accident - Auto	0.00	0	0.000	0.00	0.00
Cable Fault	0.00	0	0.000	0.00	0.00
Customer - Request	0.00	0	0.000	0.00	0.00
Failure/Defect	0.00	0	0.000	0.00	0.00
Faulty Operation	0.00	0	0.000	0.00	0.00
Fire	0.00	0	0.000	0.00	0.00
Flashover	0.00	0	0.000	0.00	0.00
Flooding	0.00	0	0.000	0.00	0.00
Heavy Rain	0.00	0	0.000	0.00	0.00
High Winds	0.00	0	0.000	0.00	0.00
Landslide	0.00	0	0.000	0.00	0.00
Manual Load Shed	0.00	0	0.000	0.00	0.00
Natural Disaster/Tsunami/Earthquake	0.00	0	0.000	0.00	0.00
Object in Line - Balloon	0.00	0	0.000	0.00	0.00
Object in Line - Man	0.00	0	0.000	0.00	0.00
Other	0.00	0	0.000	0.00	0.00
Overload	0.00	0	0.000	0.00	0.00
Transformer - Failure	0.00	0	0.000	0.00	0.00
Transformer - Overload	0.00	0	0.000	0.00	0.00
Tree	0.00	0	0.000	0.00	0.00
Vandalism	0.00	0	0.000	0.00	0.00
TOTAL	**6,873.65**	**6,479**	**3.727**	**237.27**	**63.65**

AVERAGE SYSTEM AVAILABILITY =	99.955%
NUMBER OF CUSTOMERS FOR THE PERIOD =	1,738
24 MONTH ANNUALIZED SAIDI AVERAGE FOR THE PERIOD 1/1/2017 - 12/31/2018 =	158.32
24 MONTH AVERAGE NUMBER OF CUSTOMERS FOR THE PERIOD 1/1/2017 - 12/31/2018 =	1,735

NOTES: OUTAGE CAUSES ARE LISTED IN ORDER OF SAIDI.
OUTAGES WITH ZERO CUSTOMER HOURS OR DUE TO CUSTOMER MAINTENANCE ARE NOT INCLUDED IN THE REPORT.

Maui Electric Company
Normalized Sustained Interruption Summary – System Total

FROM: JANUARY 1, 2018 **TO:** DECEMBER 31, 2018

Outage Cause	Interruption Count	% of Total	Customer Hours	% of Total
EQUIPMENT	**176**	**24.79%**	**60,975.78**	**22.38%**
Failure/Defect	19	2.68%	27,194.68	9.98%
Deterioration/Corrosion	86	12.11%	18,403.65	6.76%
Cable Fault	49	6.90%	8,855.17	3.25%
Transformer - Failure	10	1.41%	2,825.33	1.04%
Flashover	5	0.70%	2,764.65	1.01%
Overload	4	0.56%	893.25	0.33%
Transformer - Overload	3	0.42%	39.05	0.01%
Faulty Operation	0	0.00%	0.00	0.00%
ERROR	**8**	**1.13%**	**415.07**	**0.15%**
Other Company Personnel	5	0.70%	412.18	0.15%
Switching	3	0.42%	2.88	0.00%
GENERATION	**8**	**1.13%**	**23,630.12**	**8.67%**
Auto UFLS	8	1.13%	23,630.12	8.67%
Manual Load Shed	0	0.00%	0.00	0.00%
MAINTENANCE	**255**	**35.92%**	**9,192.03**	**3.37%**
Forced	50	7.04%	4,890.65	1.80%
Scheduled	204	28.73%	4,293.13	1.58%
System Change	1	0.14%	8.25	0.00%
UNKNOWN	**15**	**2.11%**	**4,871.30**	**1.79%**
Unknown	15	2.11%	4,871.30	1.79%
OTHER	**1**	**0.14%**	**20.67**	**0.01%**
Other	1	0.14%	20.67	0.01%
VEGETATION	**155**	**21.83%**	**77,669.78**	**28.51%**
Tree/Branches	140	19.72%	73,568.23	27.01%
Overgrown	15	2.11%	4,101.55	1.51%
WEATHER	**33**	**4.65%**	**40,313.03**	**14.80%**
High Winds	18	2.54%	33,216.00	12.19%
Lightning	15	2.11%	7,097.03	2.61%
Heavy Rain	0	0.00%	0.00	0.00%
Natural Disaster/Tsunami/Earthquake	0	0.00%	0.00	0.00%
Landslide	0	0.00%	0.00	0.00%
Flooding	0	0.00%	0.00	0.00%
PUBLIC (NON-UTILITY)	**59**	**8.31%**	**55,310.12**	**20.30%**
Object in Line - Foreign Object	7	0.99%	30,818.12	11.31%
Accident - Auto	14	1.97%	14,719.80	5.40%
Object in Line - Animal	19	2.68%	6,821.33	2.50%
Accident - Other	6	0.85%	2,006.33	0.74%
Accident - Construction	5	0.70%	373.70	0.14%
Vandalism	1	0.14%	293.60	0.11%
Fire	2	0.28%	153.92	0.06%
Customer - Equipment	4	0.56%	102.95	0.04%
Object in Line - Balloon	1	0.14%	20.37	0.01%
Customer - Request	0	0.00%	0.00	0.00%
Object in Line - Man	0	0.00%	0.00	0.00%
Total	**710**		**272,397.90**	

NOTES: OUTAGES WITH ZERO CUSTOMER HOURS OR DUE TO CUSTOMER MAINTENANCE ARE NOT INCLUDED IN THE REPORT.

Maui Electric Company
Normalized Sustained Interruption Summary – Maui

FROM: JANUARY 1, 2018 **TO:** DECEMBER 31, 2018

Outage Cause	Interruption Count	% of Total	Customer Hours	% of Total
EQUIPMENT	**162**	**25.31%**	**52,283.35**	**31.50%**
Failure/Defect	18	2.81%	27,185.88	16.38%
Deterioration/Corrosion	80	12.50%	14,862.60	8.95%
Cable Fault	44	6.88%	5,202.38	3.13%
Flashover	5	0.78%	2,764.65	1.67%
Transformer - Failure	9	1.41%	2,145.83	1.29%
Overload	3	0.47%	82.95	0.05%
Transformer - Overload	3	0.47%	39.05	0.02%
Faulty Operation	0	0.00%	0.00	0.00%
ERROR	**6**	**0.94%**	**398.97**	**0.24%**
Other Company Personnel	4	0.63%	397.68	0.24%
Switching	2	0.31%	1.28	0.00%
GENERATION	**3**	**0.47%**	**18,277.97**	**11.01%**
Auto UFLS	3	0.47%	18,277.97	11.01%
Manual Load Shed	0	0.00%	0.00	0.00%
MAINTENANCE	**245**	**38.28%**	**7,494.70**	**4.52%**
Scheduled	200	31.25%	4,211.20	2.54%
Forced	45	7.03%	3,283.50	1.98%
System Change	0	0.00%	0.00	0.00%
UNKNOWN	**12**	**1.88%**	**1,069.63**	**0.64%**
Unknown	12	1.88%	1,069.63	0.64%
OTHER	**1**	**0.16%**	**20.67**	**0.01%**
Other	1	0.16%	20.67	0.01%
VEGETATION	**142**	**22.19%**	**54,458.38**	**32.81%**
Tree/Branches	129	20.16%	50,568.85	30.47%
Overgrown	13	2.03%	3,889.53	2.34%
WEATHER	**22**	**3.44%**	**8,128.25**	**4.90%**
High Winds	11	1.72%	7,137.35	4.30%
Lightning	11	1.72%	990.90	0.60%
Heavy Rain	0	0.00%	0.00	0.00%
Natural Disaster/Tsunami/Earthquake	0	0.00%	0.00	0.00%
Landslide	0	0.00%	0.00	0.00%
Flooding	0	0.00%	0.00	0.00%
PUBLIC (NON-UTILITY)	**47**	**7.34%**	**23,848.17**	**14.37%**
Accident - Auto	13	2.03%	12,228.90	7.37%
Object in Line - Foreign Object	5	0.78%	5,295.42	3.19%
Object in Line - Animal	14	2.19%	4,595.27	2.77%
Accident - Other	5	0.78%	925.40	0.56%
Accident - Construction	4	0.63%	329.70	0.20%
Vandalism	1	0.16%	293.60	0.18%
Fire	2	0.31%	153.92	0.09%
Object in Line - Balloon	1	0.16%	20.37	0.01%
Customer - Equipment	2	0.31%	5.60	0.00%
Customer - Request	0	0.00%	0.00	0.00%
Object in Line - Man	0	0.00%	0.00	0.00%
Total	**640**		**165,980.08**	

NOTES: OUTAGES WITH ZERO CUSTOMER HOURS OR DUE TO CUSTOMER MAINTENANCE ARE NOT INCLUDED IN THE REPORT.

Maui Electric Company
Normalized Sustained Interruption Summary – Molokai

FROM: JANUARY 1, 2018 **TO:** DECEMBER 31, 2018

Outage Cause	Interruption Count	% of Total	Customer Hours	% of Total
EQUIPMENT	**11**	**26.19%**	**6,541.47**	**6.57%**
Cable Fault	5	11.90%	3,652.78	3.67%
Deterioration/Corrosion	3	7.14%	1,390.08	1.40%
Overload	1	2.38%	810.30	0.81%
Transformer - Failure	1	2.38%	679.50	0.68%
Failure/Defect	1	2.38%	8.80	0.01%
Faulty Operation	0	0.00%	0.00	0.00%
Flashover	0	0.00%	0.00	0.00%
Transformer - Overload	0	0.00%	0.00	0.00%
ERROR	**0**	**0.00%**	**0.00**	**0.00%**
Other Company Personnel	0	0.00%	0.00	0.00%
Switching	0	0.00%	0.00	0.00%
GENERATION	**2**	**4.76%**	**2,959.83**	**2.97%**
Auto UFLS	2	4.76%	2,959.83	2.97%
Manual Load Shed	0	0.00%	0.00	0.00%
MAINTENANCE	**2**	**4.76%**	**1,261.55**	**1.27%**
Forced	2	4.76%	1,261.55	1.27%
Scheduled	0	0.00%	0.00	0.00%
System Change	0	0.00%	0.00	0.00%
UNKNOWN	**2**	**4.76%**	**3,331.55**	**3.35%**
Unknown	2	4.76%	3,331.55	3.35%
OTHER	**0**	**0.00%**	**0.00**	**0.00%**
Other	0	0.00%	0.00	0.00%
VEGETATION	**11**	**26.19%**	**23,156.28**	**23.26%**
Tree/Branches	10	23.81%	22,980.28	23.09%
Overgrown	1	2.38%	176.00	0.18%
WEATHER	**8**	**19.05%**	**32,160.10**	**32.31%**
High Winds	7	16.67%	26,078.65	26.20%
Lightning	1	2.38%	6,081.45	6.11%
Flooding	0	0.00%	0.00	0.00%
Heavy Rain	0	0.00%	0.00	0.00%
Landslide	0	0.00%	0.00	0.00%
Natural Disaster/Tsunami/Earthquake	0	0.00%	0.00	0.00%
PUBLIC (NON-UTILITY)	**6**	**14.29%**	**30,133.38**	**30.27%**
Object in Line - Foreign Object	1	2.38%	25,515.22	25.63%
Accident - Auto	1	2.38%	2,490.90	2.50%
Object in Line - Animal	3	7.14%	2,116.17	2.13%
Customer - Equipment	1	2.38%	11.10	0.01%
Accident - Construction	0	0.00%	0.00	0.00%
Accident - Other	0	0.00%	0.00	0.00%
Customer - Request	0	0.00%	0.00	0.00%
Fire	0	0.00%	0.00	0.00%
Object in Line - Balloon	0	0.00%	0.00	0.00%
Object in Line - Man	0	0.00%	0.00	0.00%
Vandalism	0	0.00%	0.00	0.00%
Total	**42**		**99,544.17**	

NOTES: OUTAGES WITH ZERO CUSTOMER HOURS OR DUE TO CUSTOMER MAINTENANCE ARE NOT INCLUDED IN THE REPORT.

Maui Electric Company
Normalized Sustained Interruption Summary – Lanai

FROM: JANUARY 1, 2018 **TO:** DECEMBER 31, 2018

Outage Cause	Interruption Count	% of Total	Customer Hours	% of Total
EQUIPMENT	**3**	**10.71%**	**2,150.97**	**31.29%**
Deterioration/Corrosion	3	10.71%	2,150.97	31.29%
Failure/Defect	0	0.00%	0.00	0.00%
Cable Fault	0	0.00%	0.00	0.00%
Overload	0	0.00%	0.00	0.00%
Faulty Operation	0	0.00%	0.00	0.00%
Flashover	0	0.00%	0.00	0.00%
Transformer - Failure	0	0.00%	0.00	0.00%
Transformer - Overload	0	0.00%	0.00	0.00%
ERROR	**2**	**7.14%**	**16.10**	**0.23%**
Other Company Personnel	1	3.57%	14.50	0.21%
Switching	1	3.57%	1.60	0.02%
GENERATION	**3**	**10.71%**	**2,392.32**	**34.80%**
Auto UFLS	3	10.71%	2,392.32	34.80%
Manual Load Shed	0	0.00%	0.00	0.00%
MAINTENANCE	**8**	**28.57%**	**435.78**	**6.34%**
Forced	3	10.71%	345.60	5.03%
Scheduled	4	14.29%	81.93	1.19%
System Change	1	3.57%	8.25	0.12%
UNKNOWN	**1**	**3.57%**	**470.12**	**6.84%**
Unknown	1	3.57%	470.12	6.84%
OTHER	**0**	**0.00%**	**0.00**	**0.00%**
Other	0	0.00%	0.00	0.00%
VEGETATION	**2**	**7.14%**	**55.12**	**0.80%**
Overgrown	1	3.57%	36.02	0.52%
Tree/Branches	1	3.57%	19.10	0.28%
WEATHER	**3**	**10.71%**	**24.68**	**0.36%**
Lightning	3	10.71%	24.68	0.36%
Flooding	0	0.00%	0.00	0.00%
Heavy Rain	0	0.00%	0.00	0.00%
High Winds	0	0.00%	0.00	0.00%
Landslide	0	0.00%	0.00	0.00%
Natural Disaster/Tsunami/Earthquake	0	0.00%	0.00	0.00%
PUBLIC (NON-UTILITY)	**6**	**21.43%**	**1,328.57**	**19.33%**
Accident - Other	1	3.57%	1,080.93	15.73%
Object in Line - Animal	2	7.14%	109.90	1.60%
Customer - Equipment	1	3.57%	86.25	1.25%
Accident - Construction	1	3.57%	44.00	0.64%
Object in Line - Foreign Object	1	3.57%	7.48	0.11%
Accident - Auto	0	0.00%	0.00	0.00%
Customer - Request	0	0.00%	0.00	0.00%
Fire	0	0.00%	0.00	0.00%
Object in Line - Balloon	0	0.00%	0.00	0.00%
Object in Line - Man	0	0.00%	0.00	0.00%
Vandalism	0	0.00%	0.00	0.00%
Total	**28**		**6,873.65**	

NOTES: OUTAGES WITH ZERO CUSTOMER HOURS OR DUE TO CUSTOMER MAINTENANCE ARE NOT INCLUDED IN THE REPORT.

DEFINITION OF TERMS

OUTAGE

The state of a component when it is not available to perform its intended function due to some event directly associated with that component. An outage may or may not cause an interruption of service to consumers depending on the system configuration.

INTERRUPTION

The loss of service to one or more consumers and is a result of one or more component outages.

INTERRUPTION DURATION

The period from the initiation of an interruption to a consumer until service has been restored to that consumer.

MOMENTARY INTERRUPTION

An interruption that has a duration limited to the period required to restore service by automatic or supervisory-controlled switching operations or by manual switching at locations where an operator is immediately available. Such switching operations must be completed in a specific time not to exceed five minutes. Previous issues of this report indicated that a momentary interruption has duration not to exceed one minute. IEEE Std 1366™-2012: IEEE Guide for Electric Power Distribution Reliability Indices indicated that momentary interruptions will have duration of five minutes or less.

SUSTAINED INTERRUPTION

Any interruption not classified as a momentary interruption. Only this type of interruption is included in the reliability indices within this report. In conformance with the guidelines established in the IEEE Std 1366™-2012: IEEE Guide for Electric Power Distribution Reliability Indices, a sustained interruption has duration of over five minutes.

CUSTOMER INTERRUPTION

One interruption of one customer.

NOTE: Interruptions to customers at their request (e.g., customer maintenance) are not considered.

RELIABILITY INDICES

Reliability indices used in this report conform to standards proposed by both the Edison Electric Institute (EEI) and the Institute of Electrical and Electronics Engineers (IEEE) unless otherwise indicated in the above definitions. Five reliability indices that convey a meaningful representation of the level of reliability were selected and are presented in this report. These reliability indices are as follows:

AVERAGE SERVICE AVAILABILITY INDEX (ASAI)

Total customer hours actually served as a percentage of total customer hours possible during the year. This indicates the extent to which electrical service was available to all customers. This index has been commonly referred to as the "Index of Reliability." A customer-hour is calculated by multiplying the number of customers by the number of hours in the period being analyzed.

$$ASAI = \frac{\sum \text{No. of Customer Hours Actually Served During the year}}{\sum No. of\ Customer\ Hours\ Possible\ During\ the\ year} \times 100\%$$

SYSTEM AVERAGE INTERRUPTION FREQUENCY INDEX (SAIFI)

The number of customer interruptions per customer served during the year. This index indicates the average number of sustained interruptions experienced by all customers serviced on the system.

$$SAIFI = \frac{\sum \text{No. of Customer Interruptions Experienced During the year}}{\text{Average No. of Customers Served During the year}}$$

CUSTOMER AVERAGE INTERRUPTION DURATION INDEX (CAIDI)

The interruption duration per customer interrupted during the year. This index indicates the average duration of an interruption for those customers affected by a sustained interruption.

$$CAIDI = \frac{\sum \text{Duration of Interruptions} \times \text{No. of Customers Affected}}{\sum \text{No. of Customer Interruptions Experienced During the year}}$$

SYSTEM AVERAGE INTERRUPTION DURATION INDEX (SAIDI)

The interruption duration per customer served during the year. This index indicates the average interruption time experienced by all customers serviced on the system.

$$SAIDI = \frac{\sum \text{Duration of Interruptions} \times \text{No. of Customers Affected}}{\text{Average No. of Customers Served During the year}}$$